DOCUMENT RESUME

ED 261 465 EA 017 991

AUTHOR	Willis, Bernice H.; And Others
TITLE	Technology and Learning: Changing Minds in a Changing World. Schooling and Technology, Volume 4.
INSTITUTION	Southeastern Regional Council for Educational Improvement, Research Triangle Park, N.C.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
PUB DATE	Jun 85
NOTE	53p.
PUB TYPE	Viewpoints (120)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Computers; *Educational Change; Educational Innovation; Educational Principles; Educational Trends; Elementary Secondary Education; *Student Attitudes; Student Development; Student Interests; Student Needs; Teacher Education; *Teacher Role; Teaching (Occupation); *Technological Advancement; Telecommunications

ABSTRACT

This document, the publishers' fourth volume on schooling and technology, explores in detail the mismatch between the historically developed purposes, roles, and practices of the schools and the nature of the new technology. Specifically, it juxtaposes characteristics of today's children and the currently available educational technologies (including television) with the skills, roles, and professional training of today's teachers, and on this basis, it suggests a set of new skills and roles for teachers and describes preconditions for successful change. After a brief introduction, part 1 focuses on the behavior, perception, thinking, and learning of the contemporary child, as it has been shaped and influenced by electronic media. Part 2 rests on the assumption that teachers as a profession are motivated by values and beliefs that have little relevance to children raised in the electronic age. To serve these children, the teaching profession will need to adapt to a new set of working principles, shifting their role from disseminators of knowledge to collaborators in learning. Part 3 focuses on the immediate concerns that confront educators. Elements for successful reform described in the literature are reviewed and linked to existing models of growth and change that can serve as bridges to the major structural changes in educational systems that many believe will be necessary to meet the needs of contemporary learners. One model is the Waterford School (Orem, Utah), a private K-12 school participating in the research, development, and implementation of electronic educational materials and methods. conclusion sets forth a five-point agenda of critical tasks for the educational community. Seven pages of notes and bibliography conclude the document. (TE)

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Southeastern Regional Council for Educational Improvement

Schooling and Technology Series
Volume 4

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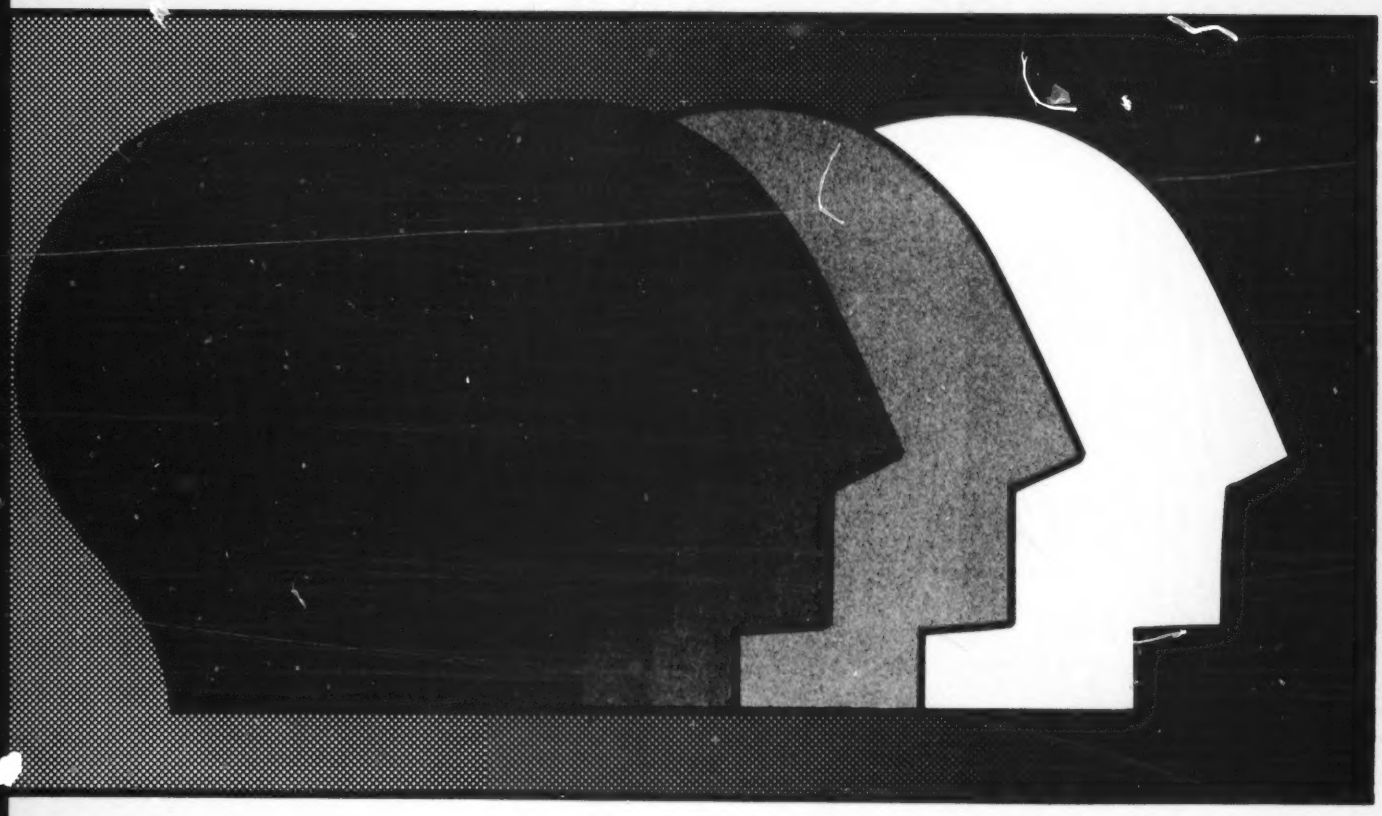

EA 017 991

Technology and Learning:

Changing Minds in a Changing World

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June 1985

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The activities reported in this publication were supported, in whole or in part, by a grant from the National Institute of Education, Department of Education. However, the opinions expressed here do not necessarily reflect the position or policy of the U.S. Department of Education, the Southeastern Regional Council for Educational Improvement member states' departments of education, or their chief state school officers.

Southeastern Regional Council
for Educational Improvement

Schooling and Technology Series
Volume 4

by
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June 1985

Technology and Learning:

Changing minds in a changing world

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Foreword

This is the fourth volume on "Schooling and Technology" published by the Southeastern Regional Council for Educational Improvement in less than two years. A fifth volume will follow shortly. While this series of publications bears witness to the Council's ongoing involvement in assessing the effects and influencing future uses of the new electronic technologies arriving in the nation's schools, it also reflects the changing nature of the issues that have been confronting policy makers and practitioners alike.

Volume 1, *State-level Policy Initiatives*, published in the summer of 1983, provided an up-to-date summary of state-level policies and programs across the country that were shaping technology's roles in the public schools. Based on the information and insights generated by that survey, Volume 2, *The New Equation: Student, Teacher, Unlimited Information*, began to explore some of the major implications of the new computer technologies for public education as a whole. Specifically, it addressed the changing economic context and resulting skills needed for employment, projected changes in the teaching-learning process, and identified key policy questions and options before the education community. Even as these first two volumes examined emerging policies and broader implications of the new technologies, schools continued to acquire the new tools at an ever more hurried pace and to include them in their teaching and administrative processes. Volume 3, *Planning for the Future: A Collaborative Model*, described some of these latter efforts and evolving issues. It provided an interpretive summary of "Creative Partnerships in Technology: An Open Forum," an invitational conference sponsored by the Council in late 1983 and attended by some 100 education leaders in the Southeast who were taking the first steps into the new high-tech age of schooling.

The conference itself offered ample evidence of an astounding fact: the new technology, particularly the computer, had clearly arrived in the schools. Furthermore, its use was promoted with great energy, enthusiasm, and belief in its educational potential, a phenomenon that could be observed nationwide. At the same time, there were beginning to emerge serious questions and concerns regarding the effective implementation and institutional integration of the technology—questions of scheduling, hardware compatibility, the quality of courseware, staff development, and equity, to name a few.

To be sure, difficulties and complications were to be expected during this transition from introduction and adoption of the new tools to their implementation and institutionalization. But there were increasing signs that a greater challenge faced educators than the mere application of effective change strategies. In tracing the short, rapid history of computer

technology in the schools, Volumes 1-3 reflected not only a new awareness of changing vocational needs of students and of barriers to effective integration of electronic technologies in the schools, but also the growing realization that the technologies were changing thought processes as well. It became evident that the computer technologies in their potential clearly transcend the schools' institutional practices and boundaries. That is, the complications and less than satisfying uses of the technologies can be traced primarily to a basic mismatch between the historically developed purposes, roles, and practices of the schools and the very nature of the new technology.

Volume 4, *Changing Minds in a Changing World*, explores this mismatch in some detail. In particular, it juxtaposes characteristics of today's children and the currently available educational technologies (including television) with the skills, roles, and professional training of today's teachers. As a result, it suggests a set of new skills and roles for teachers and describes basic preconditions for successful change.

The special emphasis on teaching in this volume is based on the recognition that the new electronic technologies will not be integrated into the teaching-learning process unless teachers understand them, acquire the skills to use them, and exploit their unique strengths. It is further guided by the conviction that ". . . good teaching is at the very heart of good schools" (E. Boyer, 1984). The teaching profession, therefore, is viewed as a key element in realizing the educational potential of the computer technologies. At the same time, it is held, however, that good teaching requires ongoing institutional responsiveness to changing circumstances which, in turn, call for an ongoing exploration of their educational meaning and direction. Thus, the emphasis on good teaching points back to the schools themselves and to the environments that shape them.

In short, this publication invites the reader to view the current schooling and technology debate from a different perspective—one that suspends, at least for the moment, established beliefs about what and how children *should* be taught. Its purpose is not so much to consider whether computers have a place in classrooms, for example, but whether classrooms—as physical structures and administrative clusterings of children—will remain the same in the information age. It is offered in the hope that it will stimulate educators and the public to create an institutional context in which the great educational potential of electronic technologies can be realized and the educational needs of contemporary society can be met.

Charles J. Law, Jr.
Executive Director

Introduction

One creates a machine for a particular and limited purpose. But once the machine is built, we discover—sometimes to our horror, usually to our discomfort, always to our surprise—that it has ideas of its own; that it is quite capable not only of changing our habits, but . . . of changing our habits of mind.

—Neil Postman,
The Disappearance of Childhood

Does the introduction of the computer into the nation's elementary and secondary classrooms signal the beginning of a revolution in how students learn—and, therefore, in how teachers teach? We believe that it does, and certainly, with Postman, we believe the electronic technologies already are "changing our habits . . . and . . . our habits of mind," affecting how many of us think about, perceive, receive, and exchange information.

If that is true, as increasing evidence suggests, what are the implications for education and educators? Obviously, the accumulation and distribution of information have been a central task of teachers and schools since the invention of the printing press more than 500 years ago. We invest the authority of knowledge in these institutions; their influence is felt in every part of our individual lives and our collective culture. We care about them deeply; they are at the core of many of our traditions.

Yet, rather suddenly, teachers and schools are challenged to incorporate, adapt to, or in some way accommodate in the scheme of this traditional structure the ubiquitous computer, arriving in the nation's classrooms each day by the hundreds. Symbol of an ever-growing assortment of electronic technologies, it, too, has capacities to accumulate and distribute information—capacities so powerful, we believe, that it cannot help but change the way we think and learn and thus *must* affect the way we teach.

This publication is about technology and learning, teachers and teaching, children and change. It is far more reflective than prescriptive. Its genesis is found in observations we have made about four major trends in our society and in our schools. These are:

- ***Technology is not something for educators to deal with in the future; it is today's reality.*** Television's presence has long been felt in classrooms and schools through its influence on the minds of students. It is a technological innovation that has altered our concepts of time and space, our relationship to print as an instructional medium, and the ways in which we relate to each other. And now computers are entering the schools as instructional tools (see box), altering the education/technology relationship in still unexplored ways. Policies related to computer literacy and electronic technology are being introduced in most states with definitions, guidelines, and requirements as diverse as the states enacting them.
- ***There exists a wide gap between the number of new technological tools in the schools and the number of teachers who can use them with understanding.*** High-tech training for prospective and current teachers, in most locations, appears to lag behind the need. A great deal of skepticism remains in the profession about the value and usefulness of these new "teaching machines." So while the computers come in ever greater numbers, many educators are at a loss in knowing what to do with them. In some quarters, the limitless instructional potential of computers evokes the same fearful response that the idea of instructional television did in an earlier time.
- ***National commissions and the general public seem to share the view that the quality of programs and teaching is slipping in our public schools.*** Teaching, in particular, is considered to be a profession in crisis.
- ***While parents and the public complain about teachers, teachers complain about students.*** They cite a lack of support for discipline, "unreachable" students, and lack of respect and motivation on the part of students as reasons why so many of them leave teaching. The teacher-student relationship has changed in a way that is frustrating and painful for teachers—and, it is reasonable to suspect, for students as well.

We believe that there are important relationships between and among these four "conditions of education." In analyzing the literature about today's learner, the structure of schools, the teaching profession, the strengths and limitations of many instructional approaches, and the process of reform and change, we have arrived at our

own set of conclusions and developed our own set of assumptions about educational change, progress, and reform. These form the framework for this publication.

Our first assumption is that the bells, whistles, and whirrs of modern technology are fast becoming a pervasive, inescapable force in our lives, and these new electronic tools are changing the way all of us (especially children) think and perceive our world. We frame our existence in terms of time and space, and those constructs are transformed markedly for all of us in this new "information age."

Second, schools (and contemporary teaching styles) are creations of and remain captive to print technology, reflecting the style and thinking patterns of an era that is being altered. To the extent that schools remain predominantly tied to the patterns and learning processes of the print-dominated age, they will become increasingly less able to serve the learning needs of students effectively.

Third, despite an increasing understanding of the process of reform, public education seems to be reacting to the swirl of change around it in a conservative and traditional way. Since the profession of teaching always has been devoted to preserving and sustaining continuity in society, it is, by definition, fundamentally at odds with today's methods of information exchange, which are more rapid, simultaneous, visual, and interactive. The consequences of this clash are friction and stress: old systems and values are, in effect, threatened by the new.

Our fourth assumption is that reform that makes sense must be based on an understanding of the nature of the change taking place and a willingness to explore the differences between traditional beliefs about schooling and the realities of change inspired by new technology. Good decisions about the appropriate uses of technology in schools begin with questions about purpose, need, and character—not of hardware and software, but of our schools and the students, teachers, and instructional technologies in them. Guided further by an understanding of what is happening outside the classroom—in our homes, our families, our work places, our minds—we will be able to make good decisions about how to employ technology as an aid in helping young people to learn and grow.

Finally, change is a constant in our individual lives and our collective destiny. What is different today is that we are moving toward a powerful understanding of the *process* of change, introducing the notion that we may take charge of how, when, and how much we'll change, rather than simply adapt in reaction to what is occurring in the world around us. Thus, this publication also looks at the process of change as it relates to the important issues of educational reform.

Beginning with these observations and assumptions, we invite educators and policy makers, in the pages that follow, to step back from day-to-day management decisions to consider the various threads which are weaving a pattern before us. To understand the pattern and how it is developing, we believe, creates the opportunity to control it; to forsake that understanding is to be controlled *by* it.

Our effort is put together in three parts. In Part I, the focus is on the contemporary child. The influence of technology can best be seen, we believe, in our children—for they are truly products of this high-tech world and reflect their heritage in significant differences in behavior, perception, thinking, and learning. Clearly these differences have important implications for educators.

Part II of the publication rests on the assumption that teachers as a profession are motivated by values and beliefs that have less and less relevance to children raised in the electronic age. So our purpose is to consider the nature of the mismatch and what needs to be and can be done to resolve it. A working premise is that it is unlikely that children will change to adopt the values and beliefs of an earlier era. To serve them, it is the profession that will need to adapt to a new set of working principles.

Finally, in Part III, we narrow the focus from the larger concepts of change to consider the immediate concerns that confront educators. Certainly and inescapably, education is involved with reforms. We examine a number of elements for successful reform described in the literature and link those to change/growth models that exist in public education today. These models, we suggest, can serve as bridges as we shape the major structural changes in educational delivery systems that many believe will be necessary to meet the needs of contemporary learners.

This consideration of the nature of the impact of technology on schooling is a large topic to organize and make coherent. We are, therefore, necessarily general in many of our observations, conclusions, and recommendations. We recognize that this presentation is but a step in the process of evaluating, analyzing, developing options, and making decisions about the future of our schools, about the profession of teaching, and, above all, about the nature and range of learning support we wish to provide for young people. But every journey begins with a single step, and every change of habit begins first with a change of mind.

Computers By the Numbers

The numbers change daily, but one thing is certain: the use of computers in the nation's public schools is increasing at an amazing rate. In 1981, only 41 percent of the nation's school *districts* had one or more computers; today, 80 percent or more of the nation's school *buildings* have at least one computer. Well over a million microcomputers were in use for instructional purposes in mid-1985.

According to one survey, 27 states and the District of Columbia fall below the national average for computer use in schools, with fewer than 70 percent of schools in these jurisdictions owning at least one computer. The ratios of students to computers, conservatively reported, offers a picture of unmet challenges: on the elementary level nationally, there are 100 students for every computer; on the junior high level, 85 to 1, and on the senior high level, 70 to 1. Wealthy school districts in rural/suburban settings have an overall ratio of 1 computer for every 63 students, compared to a ratio of 137 to every computer in poor, urban districts.

Source: Educational Technology, January 1986; Market Data Retrieval of Connecticut.

Part I: The changing child

Part I: The changing child

Each medium of communication produces social and psychological effects on its audience, particular social relations and a particular form of consciousness or way of thinking, that are quite independent of the content being transmitted. These effects constitute the message of the medium.

—Patricia Marks Greenfield,
Mind and Media:
The Effects of Television,
Video Games, and Computers

When considering the present or projected impact of technology on education, there is a tendency to put the problem "out there": to talk about the costs of hardware, how difficult it is to find good software, or the problems of retraining staff. Actually (so it seems to us), the "problem" confronting education is one of perception and of people, rather than of machines or even of dollars. It is a human challenge: to understand what it is we believe, what we value, what we have been, and what we are becoming.

To understand what we are becoming, we must look at our children. These young people—the "Now" children of the communications age—experience their world differently and think about it differently than do adults, because for them it *is* different. Many influences help shape their perceptions and mental processes. Today's children, for example, cannot imagine a world without television. Many adults, however, spent their formative years responding to different stimuli and, in the process, developed different patterns of thinking and behaving—patterns that are challenged daily by technology's influence.

For adults raised in a different time, it seems that the world of today's children offers less order, depth, and stability than that of their parents. It is a world that isolates them at the same time that it makes them more dependent on the decisions of others. Perhaps most importantly, it overwhelms them with information. The result is a generation of children who mirror the pace and style of the technologies that dominate their lives: cosmopolitan and knowledgeable—but superficial; somewhat disoriented and fragmented; adaptable and accustomed to change; quick to mature; more visual than verbal; and, overall, less respectful, less patient intellectually, and less disciplined than their parents.

It is a generalization, of course, to talk of "today's children" or, for that matter, of "today's teachers," particularly in view of the fact that diversity is perhaps the most striking characteristic of American society today. Nonetheless, there are common themes to be observed in the behavior of the current generation of youth—themes different from those that typically characterize their parents and teachers. There are also common voices raised in concern and frustration among educators. Those common themes and voices give credence to generalizations about today's teachers and youth and, we believe, are a source of important understanding for educators.

As we explore these themes in the following pages, our purposes are two: to better understand the effects of contemporary electronic technologies on children's perceptions, development, and behavior and to examine the impact that changing behaviors and perceptions have on traditional teaching and learning.

Technology's impact: changes in the mind

In every aspect of our lives, we can see and feel the impact of rapid technological change. Computers are but the latest in a long list of innovations, all less than a century old and all with profound implications for society: plastics, the theory of relativity, the light bulb and vacuum tube, the IQ test, nuclear fission, the pill, television, DDT, and the discovery of DNA. These events and inventions are only the pebbles, however; the ripples they produce continue infinitely to create the future. Their impact is seen in altered family structures and lifespans, in shifting political priorities, in more complex interrelationships among nations, and in the increased power and dangers of military and industrial technologies. These belief-altering discoveries have been our children's reality for all of their lives; small wonder that they think and behave differently from the adults around them.

Of all the changes, none is more important than those which occur in the mind. These can be observed—and measured—in the ways children perceive time and space, absorb information, process it, and use it to experience life.

Evidence of such change is particularly apparent in our schools. In their print-oriented values and structures, they create a striking counterpoint to the attitudes and experiences of contemporary learners. Schools, it seems, continue to operate on the assumption that thinking and learning processes remain unaffected by the dramatic and rapid technological changes affecting society—an assumption that is challenged daily in classrooms throughout the country.

Nonetheless, despite a growing body of research on computers and learning, there is very little research that examines the impact that the many technologies of the information age have on the way we think and learn. For now, an understanding of how today's children think and learn—and how they differ from their parents—must be pieced together from our knowledge of change, technologies, and the observed behavior of this high-tech generation (see box). That process yields a profile of young learners who are distinctly different from the print-influenced adults of prior generations in three fundamental ways:

- the way they process and use information,
- the way they relate to others (especially adults), and
- the way they perceive the world and their place in it.

Thus, it is hardly surprising that traditional teaching practices—essentially unchanged in over a century—and contemporary students find themselves increasingly at odds.

Research on the Influence of Change

Considerable research has been conducted on the effects of many of the factors influencing children—particularly television and, more recently, computers. But there is little hard evidence of the composite effect the many different influences are having on the way children think and learn. At best, we can piece together the results of studies on television viewing, changing family patterns, and other factors to obtain a picture of what today's child is like and what educators can expect in the future. Sources for such an activity are rich indeed. We mention several works specifically, since they offer different, yet complementary, insights into the nature of today's youth.

The first, *The Changing American Child*, by Herbert Zimiles, is a study and analysis of career teachers' observations of changes in students over the past two decades.

A historical perspective is explored in two works in particular: Philippe Ariès's classic, *Centuries of Childhood*, and a more recent work, *The Disappearance of Childhood*, by Neil Postman. These studies explore childhood as a distinct stage of life, pointing out that the concept of childhood is a social creation that has emerged only since the middle ages and is being altered in contemporary society. As was true in medieval times, today's youth are rapidly becoming "non-children." With their changing status come changes in thought, needs, and priorities.

Finally, we found particularly useful two recent works that examine various electronic media and their effects on children's minds and behavior: *Mind and Media: The Effects of Television, Video Games, and Computers*, by Patricia Marks Greenfield, and *The Second Self*, by Sherry Turkle. Greenfield's study, while raising some genuine concerns about the effects of these media on children, concludes that they can be used as invaluable learning tools. She urges that we explore the results of new research to discover how the various media can be used to promote social growth and thinking skills. A more introspective view is expressed in Turkle's study of the effects of computers on our lives, thinking, and perceptions of self. This work offers additional insight into the character of today's youth and the changing influences in their world.

The Quality of Parenting Provided By 'The Third Parent'

A report from the National Institute of Mental Health observes that "television is so entrenched in American daily life that it can only be regarded as a major socializing influence almost comparable to the family, the schools, the church, and other socializing institutions."[1] It is, in fact—as Buckminster Fuller commented many years ago—our "Third Parent." What are the qualities and conditions of parenting that children receive from this electronic "parent"? We believe there are at least five issues of interest to educators as they consider programs, policies, and procedures for meeting the learning needs of today's students. Society's "Third Parent" is, we have found:

• ***Omnipresent.*** Over 98 percent of American homes have television sets, and most have more than one. In this decade, a majority of homes will have cable TV, and the medium will increasingly permit complex interactions with computers, instructors, entertainers, satellites, videotape, videodisc, and the like. Even at its present level, producers of programming in the U.S. beam well in excess of 6 million hours of broadcasting into the nation's homes each year.

• ***Influential.*** "Television may be . . . the nearest thing we have to a common school."[2] It is the central cultural arm of American society. From infancy on, children learn more about society from TV than they do from school, their parents, or any other source. "TV's role is like that of religion in pre-industrial society—TV is today's religion."

Furthermore, "children's susceptibility to television, more than any other factor in this medium's use, can be proven beyond any doubt. Its influence in their lives cannot be disputed. As technologies expand television's outreach, more and more of the world's children will be swept into its influence. The world and its future is passing into the hands of television's children."[3]

Researchers have found it difficult, however, to determine relationships between TV viewing and various measures of intellectual functioning and development in children. One group states: "It is clear that no evidence points toward positive effects (of heavy viewing). This is in contrast with reading, for example, that relates strongly and positively to measures of intellectual functioning, among others. At best, then, time viewing TV may, on the average, be viewed as 'empty time.' It is spent doing something that appears to have no beneficial effects and may have some mild detrimental effects. But more importantly, it is time not spent in activities which do relate strongly and positively to child development."[4]

Other researchers make a somewhat different case, reporting that "training sixth graders to watch television in a more active, careful way by asking penetrating questions about the shows improves their reading comprehension scores. It seems that whether or not the two media (reading and TV) stimulate the same processes depends on how the medium is being used. There is evidence that television does interfere with reading under some circumstances, but this may happen not because of an intrinsic conflict between these two media, but because the usual way of watching television is without care or effort."[5]

• ***Indiscriminate.*** By the time children reach the age of 10, 90 percent of the programs they watch are designed for adults. TV speaks a language of images, pantomime, and expressive gestures and sounds, all learned at any age without formal training. "This transparency of meaning scarcely allows for information control inside the home. Once the set is turned on, it addresses everyone in the vicinity—markedly different from print, which addresses only the reader."[6] TV is no less discriminating in terms of content; it provides virtually no "parental" guidance to ensure that children watch programming that is appropriate to their age and understanding.

• ***Controlled by the child.*** The balance of power between this one-eyed parent and the typical child is wildly in favor of the child. To begin, with a turn of the dial the child controls what she wants to watch and how long she wants to watch it. And given the absence of parental control in many instances, that power is absolute. Approximately 3 million children, ages 2 to 11, watch TV every night of the year between 11 and 11:30 p.m. Nearly a million are still watching between 1 and 1:30 a.m. On the average, children spend half again as much time watching TV as they do in school—and far more time with the "tube" than with their biological parents.

• ***Biased.*** Television is a predominantly commercial medium with a job to do: selling products. Children's TV advertising is a $600 million-a-year business. The average child in America sees 500 TV advertisements a week, or 25,000 commercials a year. More than 60 percent of these are for candy, sugared cereal, and fast foods. Most of the remainder are advertisements for toys and games. Other studies and observers have accused the commercial networks of airing programs that are frequently sexist, racist, ageist, or clearly biased in favor of middle-class values.

1. National Institute of Mental Health, *Television and Behavior: Ten Years of Scientific Progress and Implications for the Eighties*, p. 90.
2. John I. Goodlad, *A Place Called School: Prospects for the Future*, p. 42.
3. Peggy Charren, president of Action for Children's Television, quoted in Cecily Truett, "Television and Children: A Global View."
4. Nicholas Zill and James L. Peterson, *Television Viewing in the United States and Children's Intellectual, Social and Emotional Development.*
5. Patricia Marks Greenfield, *Mind and Media: The Effects of Television, Video Games, and Computers*, p. 79.
6. Rose K. Goldsen, "Television: The Insidious Teacher," p. 107.

Other Sources: Robert F. Biggs, et al., eds., *Child Nurturing in the 1980s.* John Cawley and Douglas Kelch, "Educational and Recreational Uses of Computer Technology." Institute of Electrical and Electronics Engineers, Spectrum.

Using and ordering information: excess, impatience, confusion

Extensive and fragmented knowledge

Primarily as a result of watching so much television, children today have a broader range of information at their command; they are more "streetwise," more aware of "adult" information, and more informed and active consumers than were their counterparts of the past. However, while students' knowledge base has broadened considerably, it also is quite shallow and fragmented. Although teachers may be working with a more knowledgeable child, they also are "dealing with a more confused person, one who perhaps is already accustomed to being confused, and who has less of a need to sort out and clarify what is being experienced. Teachers fear that children have become habituated to the fragmentary, untidy quality of learning and knowledge that they acquire from random snatches of television watching."[1]

Different sensory preferences

Since a predominant source of their information is visually oriented (through television and film), children are significantly more visual than their parents. At the same time, "they seem to be less tuned in auditorially and have more difficulty in analyzing, differentiating, and remembering sounds, and attend less well to spoken messages. They are much more accustomed to functioning in a visual world."[2] However, "what is not clear thus far is whether exposure to television *causes* the predominance of the visual sense or simply makes use of a naturally occurring state of development . . . is television altering the ratio of children's senses in favor of the visual, or is it simply capitalizing on a pre-existing ratio?"[3]

Researchers also have found TV-raised children to be demonstrably less literate, "not so much [because of] . . . the content of television as . . . the fact that children watch television rather than read, and reading is a skill that requires practice."[4] Furthermore, the pace as well as the form of communications affects children's behavior. Teachers and parents report that students today are more inclined to be impatient than were children of the past, are somewhat more shortsighted, are more accustomed to being entertained, and seek immediate gratification in all their activities.

Computers and thinking

It is crucial for educators to capture an understanding of the influence of computers on the minds of children if they are to serve children's learning needs effectively. Some researchers, for example, express concern for children "matching their thinking style to that of the computer—which is logical and deductive. Computer thinking is really quite simplistic and 'dumber' than the natural thinking of children of this age, which is metaphorical. Metaphorical thinking is at the base of true genius and creativity."[5]

Admittedly, there is little evidence to date to suggest that this is a pressing concern. Indeed, as computers become easier to use and increasingly interactive, most observers agree that they encourage creativity and many other skills in the children who use them. But, certainly, computers are affecting how today's children think, influencing how they construct such concepts as animate and inanimate, conscious and not conscious.

"Children playing with toys that they imagine to be alive and adults playing with the idea of mind as program are both drawn by the computer's ability to provoke and to color self-reflection," Sherry Turkle comments. "The computer is a 'metaphysical machine,' a 'psychological machine,' not just because it might be said to have a psychology, but because it influences how we think about our own."[6]

She notes that "even the most technical discussions about computers use terms borrowed from human mental functioning: programs have intentions, try their best, are more or less intelligent or stupid, communicate with one another, and become confused." In her six-year study, she observed "three stages in children's relationships with computers. First there is a 'metaphysical' stage: when young children meet computers they are concerned with whether the machines

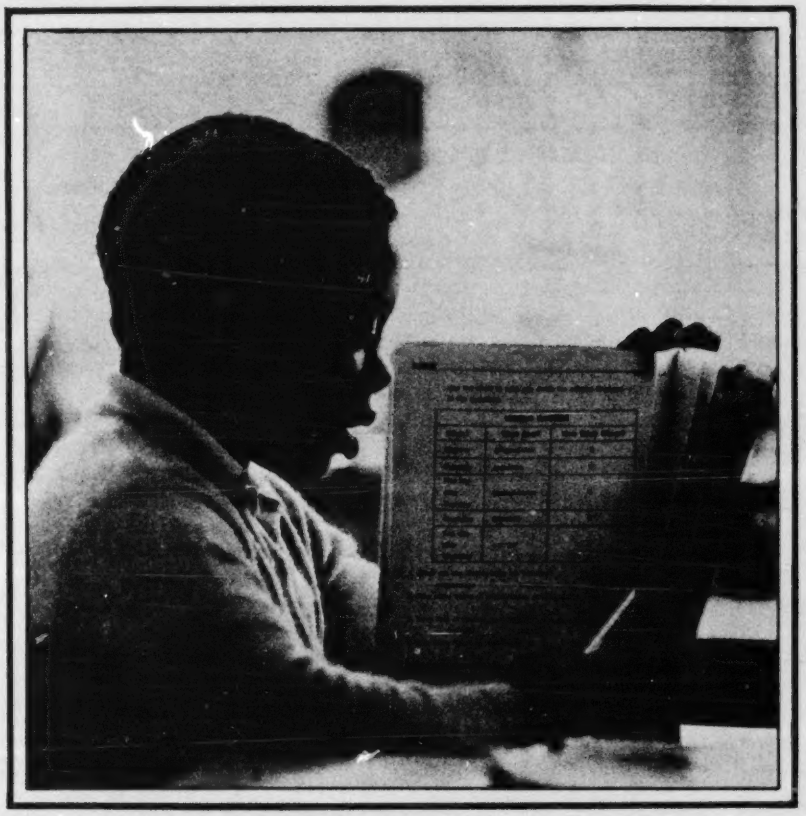
A Changing World

"Just 40 years ago . . . only one farmhouse in three had electricity. There have been corresponding advances in sanitation, diet, medical care, and other factors that affect children's health and physical development. As a result, illness in childhood that requires hospitalization has all but vanished. In countless ways, children are growing up under more stimulating and supportive circumstances. More parents are literate, are familiar with the ways of the school, and are sensitized to information about childrearing and to a psychological frame of reference. As a result of advances in birth control methods, there is more family planning, at least in the middle class. Families are smaller and siblings are less closely clustered in age. Children live in more comfortable and better equipped homes that are less densely populated, and grow up in a social climate that tends to be less authoritarian."

—Herbert Zimiles
The Changing American Child

think, feel, are alive. Older children, from age 7 or 8 on, are less concerned with speculating about the nature of the world than with mastering it. For many of them, the first time they stand in front of a computer they can master is when they play their first video game. In adolescence, experience is polarized around the question of identity, and the child's relation to the computer takes on a third character. Some adolescents adopt the computer as their major activity . . . [but] there is a more subtle and widespread way that computers enter the adolescent's world of self-definition and self-creation. A computer program is a reflection of its programmer's mind. If you are the one that wrote it, then working with it can mean getting to know yourself differently."[7]

In sum, this study concludes that computers evoke rather than determine thinking. The consequences of interaction with them are dramatically different for different people. "Children use the computer in their process of world and identity construction. They use it for the development of fundamental conceptual categories, as a medium for the practice of mastery, and as a malleable material for helping forge their sense of themselves. The computer is a particularly rich and varied tool for serving so wide a range of purposes. It enters into children's process of becoming and into the development of their personalities and ways of looking at the world. It finds many points of attachment with the process of growing up. Children in a computer culture are touched by the technology in ways that set them apart from the generations that have come before."[8]



Conflicts in the classroom

The shift in the character, thinking, and perspectives of students is a source of conflict and confusion in the classroom. Since "the school curriculum was entirely designed to accommodate the demands of literacy. . .and the biases of print,"[9] it is often at odds with learning and communication habits of contemporary children. Consider some of the curricular demands of those "biases of print": "A child evolves toward adulthood by acquiring a sense of individuality, the capacity to think logically and sequentially, the capacity to distance oneself from symbols, the capacity to manipulate high orders of abstraction, the capacity to defer gratification."[10] Furthermore, print literacy requires the ability to sit still and concentrate—an "extraordinary feat of self-control."[11] But contemporary children often do not experience childhood in such a sequential, ordered style. On the contrary, early communications and learning experiences are likely to be highly visual and less verbal, simultaneous rather than sequential, spontaneous rather than logically ordered. The frequent result: teachers have difficulty reaching students, and students resist the rigors of concentration, sequential thinking, deferred gratification, and "extraordinary self-control" required by contemporary curricula.

At a time when the media-age child is assaulted by images and information from many different sources, teachers note that "school does not seem to be a suitable vehicle for extending and clarifying what they [the students] have learned. Nor do they show a need for such amplification."[12] In short, youngsters appear to accept the confusing nature of their world and resist efforts of teachers to bring order to the fragments. Perhaps they do so in part because learning and information are no longer the sole province of schools: they exist in many different places. Thus, the rigid standards of "appropriate" and necessary

> *"There is a gap between kids' personal and cognitive development that schools don't know how to address. . . . We live in a highly sophisticated, electronically oriented society. Print slows everything down." Just so. Print means a slowed-down mind. Electronics means the speeded-up mind.*
>
> —Neil Postman, quoting Jack Blessington
> *The Disappearance of Childhood*

Verbal Media: Strengths and Limitations

We have confused reason with literacy, and rationalism with a single technology.

—Marshall McLuhan

Despite the rise of various electronic communications media—notably television—in the last half-century, public schools remain a creature of and dominated by verbal communication. The skills fostered by these methods of communication have long been valued as hallmarks of education. On closer inspection, however, one sees that they limit as well as discipline the mind, and that, increasingly, they run counter to the everyday learning and communications habits of children.

The nature of print, points out Elizabeth Eisenstein, "created a new way of organizing content, and in so doing, it promoted a new way of organizing thought. The unyielding linearity of the printed book—the sequential paragraphing, its alphabetized indices, its standardized spelling and grammar—led to the habits of thinking . . . a structure of consciousness that closely parallels the structure of typography."[1] Print fosters—indeed, it insists on—logical, systematic, and sequential thought.

From a disciplined medium comes disciplined thought. Indeed, the roots of our existing society, including the electronic technologies of television and computers, are to be found in just such ordered, logical thought. And print has other characteristics. "Print not only allows time for reflective thought in comparison with television or film," says Patricia Greenfield in her book on the effects of media on children, "it also can portray thought much better than film can." At the same time, "the verbal media, by leaving so much to be filled in by the imagination, actually adjust to the level of the child listener or viewer."[2]

Despite these obvious strengths as instructional tools, the verbal media are not without limits. Yet their dominance in the public schools tends to blur (or erase) the line between method and purpose. The result is schooling whose goals are often identical to the characteristics of print: systematic, sequential thought; "correctness" in thought and behavior (such as punctuality and emphasis on facts); and self-discipline.

Cognitively, print media are somewhat limiting and rigid. They presume a fixed body of information that always is absorbed sequentially. That assumption contradicts a reality in which we are bombarded with information that is neither orderly, sequential, or fixed. "Print is probably a less efficient way to convey information, overall, than is television, with its dynamic visual images, which are more easily understood and remembered than are words."[3]

1. Elizabeth Eisenstein, *The Printing Revolution in Early Modern Europe.*
2. Patricia Marks Greenfield, *Mind and Media: The Effects of Television, Video Games, and Computers,* p. 90.
3. Ibid., p. 93.

Other Sources: Marshall McLuhan, *Understanding Media: The Extensions of Man.* Neil Postman, *The Disappearance of Childhood.*

knowledge seem quaint and irrelevant in face of the sea of information in which young people dip continuously.

In fact, the impatience, complexity, and fluidity that characterize contemporary youngsters' thinking conflict with the skills required of our print- and lecture-oriented schools. "When one learns to read, one learns a peculiar way of behaving of which physical immobility is only one feature. Self-restraint is a challenge not only to the body, but to the mind as well. Sentences, paragraphs, and pages unfold slowly, in sequence, and according to a logic that is far from intuitive. In reading, one must wait to get the answer, wait to reach the conclusion. And while waiting, one is obliged to evaluate the validity of the sentences, or at least know when and under what conditions to suspend critical judgment.

"To learn to read is to learn to abide by the rules of a complex logical and rhetorical tradition that requires one to take the measure of sentences in a cautious and rigorous way, and, of course, to modify meanings continuously as new elements unfold in sequence. The literate person must learn to be reflective and analytical, patient and assertive, always poised, after due consideration, to say no to a text."[12]

Television as an information medium is another matter. "With TV, the basis of the information hierarchy collapses. Television is first and foremost a visual medium: the average length of a shot on a network television program is somewhere between three and four seconds, the average shot on a commercial between two and three seconds. . . . Watching television requires instantaneous pattern-recognition, not delayed analytic decoding. It requires perception, not conception."[14]

The growing visual orientation of students has other implications for teachers. "The task of picturing something not seen, that is, an object or action (as described in writing), is more difficult for today's children, perhaps because they are saturated with images and pictures and have grown dependent on them as the basic method of apprehending reality. Words amplify and clarify visual images, but the visual image remains the core of experience, the key to apprehending."[15]

In honoring the primacy of print and the linear thinking and verbal ability that relate to learning through that medium, schools reflect and support other values as well. Efficiency, punctuality, obedience, and rationality are among the qualities endorsed implicitly by print and the spoken word in the schools, qualities which seem to have less relevance for media-age children.

Authority and discipline

Children today feel less constrained by authority and rules. The multiplicity of influences on today's child lead to more independent and open attitudes than were common in the past. Children are less timid, and they appear to use less support and guidance from parents and teachers and correspondingly are far more involved with and reliant upon peer groups. This new level of pragmatism and autonomy, however, includes diminished respect for authority and rules. Today's youth are much more inclined to challenge adult authority or simply to ignore it.

One physician, identifying symptoms of excessive computer use, notes another change. These "computer kids" demonstrate "edginess and crankiness—the result of mental fatigue; on-and-off communication patterns with parents and siblings; impatience because . . . parents (in contrast to the computer) take too long to get to the point, the book has too many descriptive words, or the situation is too ambiguous; fewer friends, less time spent outdoors, less physical activity."[16]

While excessive computer use may indeed cause such problems, teachers also observe these characteristics in their television-oriented children. Indeed, two-thirds of the adolescents in one extensive study[17] were at least moderately alienated from their parents, while a quarter felt seriously alienated. At the same time, teachers observe signficantly greater reliance on peer relationships for information and guidance as well as a notable absence of adult "heroes" among today's youth.[18]

In short, electronic communications media, quickened lifestyles, and fragmented family patterns have shaped a generation of young people generally characterized by impatience, greater individual isolation, less stable relationships, and greater peer orientation.

The growing autonomy of youngsters and increased emotional and intellectual distancing from adults result in a frustrating loss of authority for teachers. It is hardly a coincidence that discipline problems rank at the top of the list of concerns cited by parents and teachers alike. Loss of authority is more than an inability to suppress disruptive behavior; it is a loss of intellectual authority as well. Teachers cite, for example, a growing shortsightedness in students' intellectual outlooks. The concept of schooling as a steppingstone in a long-term process of learning and experiencing success seems more difficult for today's child to understand and accept.

Motivation

Motivation is also an important issue for educators as a result of the changing characteristics of children. For one thing, it is frustrating to compete with MTV or Steven Spielberg as a source of entertainment. Yet children raised on television, with its constant supply of new enticements and its

Implications of Rapid Change

Establishing definitive cause-and-effect linkages between societal changes and people's behavior may be impossible and is certainly beyond the scope of this publication. Nonetheless, the patterns occurring in the lives of today's children (reflected in the statistics cited below) deserve our attention. For they have much to say, we believe, about the stresses and problems created by this contemporary period of rapid, often unpredictable change.

For example, life at home for children is now remarkably different than it was 15 or 20 years ago. In 1984, 32.7 million children—one-half of all children under age 18—had their mother in the work force. And 45 percent of today's youngsters will spend at least one year living with only one parent. In 1950, one of every 12 children lived in a one-parent family. Today, one of every five children does.

There are many other signs of change. For example:

- Between 1967 and 1977, single-mother families increased 10 times as fast as two-parent families.
- 30 percent of our high school seniors currently use illegal drugs.
- In a survey of 17-year-olds conducted by the Education Commission of the States, 13 percent could not perform reading tasks considered minimal for functional literacy; 28 percent could not answer questions testing literal comprehension; 53 percent could not write a letter correcting a billing error; 85 percent could not write a persuasive statement.
- One child out of 7—a total of 9 million children—receives virtually no health care.
- Suicide is the second major cause of death among youths 15 to 24 years old.
- About 19 percent of America's youth, or three million young people, are problem drinkers.
- Almost two-thirds of the adolescents in one extensive study were at least moderately alienated from their parents, while one-quarter felt seriously alienated. The correlation between alienation from parents and the extent of delinquent activity was very clear.
- About 1.5 million young people between the ages of 10 and 18 run away from home each year.
- From 1980-82, 13.5 percent of students dropped out of high school.
- Nearly 40 percent of today's 20-year-old females were pregnant while teenagers.
- Each year, 1 in 10 girls aged 10 to 19 becomes pregnant. In 1979, 560,000 adolescents gave birth, about one-sixth of all births in the country.
- Girls under 15 are the only group of women in this country for whom the birth rate is not declining.
- 20 to 30 percent of eighth graders drink excessively.
- The NEA reports that 1 in 20 public school teachers was physically attacked by students at least once during school year 1979; 11,000 teachers required medical attention for their injuries.
- Between 1950 and 1979, the rate of serious crime (murder, forcible rape, robbery, and aggravated assault) committed by children under 15 increased 11,000 percent. The rate of nonserious child crimes (burglary, larceny, auto theft) increased by 8,300 percent.
- There were 711,142 reported cases of child abuse in 1979.
- It is projected that one half of all marriages will end in divorce.
- The federal Education Department reports that in 1983-84, 16 percent of college freshmen were enrolled in remedial reading classes, 21 percent in remedial writing, and 25 percent in remedial math courses. About 63 percent of postsecondary institutions included in the national survey reported enrollment increases of 10 percent or more in such courses.

Sources: Children Today. Children's Defense Fund, *Report on Education Research*. Education Development Center, *Improving Our Schools*. Education Week. Vernon F. Jones and Louise S. Jones, *Responsible Classroom Discipline*. National Committee for Citizens in Education, Testimony for the 1980 White House Conference on the Family. *New Designs for Youth Development*. *Statistical Abstracts*. U.S. Bureau of the Census, *Reports*. U.S. Department of Labor, Bureau of Labor Statistics, *Reports*. Youth Policy.

sophisticated entertainment techniques, seem easily bored by less gifted performances of classroom teachers. Paradoxically, while the child may be and often is assaulted by the action images of TV, television is a passive medium—and many observers believe that passivity, which undermines motivation to learn and grow, will prove to be TV's most devastating legacy. Further, information overload and rapidity of change create an unstable environment that discourages active involvement.

Yet the problem goes much deeper. Students live more in the here and now and are less impressed with the necessity to learn a seemingly irrelevant skill today because it will help them to learn something later. The "old fashioned curriculum had the virtue . . . of presenting a framework that foreshadowed the larger edifice yet to be built, providing a common set of reference points for assimilating and ordering new knowledge. This overly rigid, not always illuminating or exciting, framework is in striking contrast with the prevailing mood of rapid change and fluidity and the preoccupation with novelty that is reinforced by advertising, recorded music, and the media."[19]

Visual Media: Strengths and Limitations

"What is the use of a book," thought Alice, "without pictures or conversations?"

—Lewis Carroll
Alice's Adventures in Wonderland

Alice's complaint was, according to recent research, a legitimate one. Studies of the educational impact of various media show that the visual media (television and film) are particularly potent in promoting comprehension and memory—at least in terms of general ideas. Additionally, the power of visual imagery has a significant effect on long-term memory, for children and adults.

A Potent Source of Information

While print is especially well suited for presenting certain kinds of information, such as thoughts, television is particularly well suited to present two particular kinds of content: information about dynamic processes of action and transformation and information about space. The predominance of visual motion also suits television to the mental abilities of the young child. Furthermore, visual media, such as television, foster different information-processing skills from print. Psychology makes the distinction between parallel processing, in which a person "takes in multiple pieces of information simultaneously, and serial processing, in which a person processes one item at a time. A complex picture tends to elicit parallel processing, while words elicit serial processing."[1]

Visual media, particularly television, are more egalitarian than print. Although viewing and listening skills are necessary to fully grasp the whole of a television program, no special code, such as the alphabet, is required to use the medium. On the plus side, television and film make information (and education) available to the whole spectrum of society, regardless of age, training, physical abilities, wealth, or even native language. However, on the minus side, television is an indiscriminate medium, which does not adjust to the needs and abilities of viewers. It is also a deceptively simple medium. Because no prior skills or knowledge are required—such as those required for reading—it often is assumed that none is needed for intelligent, positive viewing. Children particularly are inclined to accept the "realities" presented in programs and advertisements indiscriminately.

By nature, the visual media—particularly television—are less precise and orderly than print, a characteristic that seems related to the marked confusion noted among contemporary students and to a disinclination to organize the information around them. There is also "vagueness" in students' verbal skills, which many attribute to the impact of television viewing. "In terms of verbal style, radio resembles print, while television resembles face-to-face communication. This fits with the point that reading and listening involve some of the same information-processing skills, while television, under usual viewing circumstances, involves a different set of skills."[2]

"Simplistic" and "present-centered" are other characteristics of visual media (especially television) that pose special challenges to teachers. "Television cannot be much improved, at least in the matter of its symbolic form or the context in which it is experienced or its speed-of-light movement of information. In particular, television is not a book, and can neither express the ideational content that is possible in typography nor further the attitudes and social organization associated with typography. Television, for example, does not have effective resources for communicating a sense of either the past or the future. It is a present-centered medium."[3]

1. Patricia Marks Greenfield, *Mind and Media: The Effects of Television, Video Games, and Computers*, p. 20.
2. Ibid., p. 80.
3. Neil Postman, *The Disappearance of Childhood*, p. 113.

Other Sources: John Condry and Douglas Keith, "Educational and Recreational Uses of Computer Technology." National Institute of Mental Health, *Television and Behavior: Ten Years of Scientific Progress and Implications for the Eighties*. Ellen Wartella, *Children Communicating: Media and Development of Thought, Speech, Understanding*.

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Diversity among children

In describing common traits of today's youth, one is struck by the tremendous diversity that exists in any one group. Because of the fast pace, mobility, and changing social patterns of contemporary American society, children are *un*like one another in important ways. "Variation in access to different forms of knowledge and the very large differences in children's ability to integrate and correlate that which they see and hear serve to compound the range of variation in background knowledge and intellectual competence"[20] with which teachers must contend. This diversity seems to contribute to problems in communication—especially between adults and children, but even among peers—since there are fewer shared references.

Shrinking childhood

Repeatedly, teachers observe acceleration in the maturation of their students: they develop earlier physically, socially, and psychologically; they assume greater autonomy at an earlier age; and they are given greater responsibility at younger ages. The consequence is a blurring of the distinctions between adult and child. Indeed, educators not only observe this, but contribute to the process by accelerating the learning pace to offer information at younger and younger ages than in the past.

Perceptions of themselves and others

Interviews with youngsters and adults reveal a shift in perceptions resulting from exposure to or involvement with computers. "Before the computer, the animals . . . seemed our nearest neighbors in the known universe. Computers, with their interactivity, their psychology, with whatever fragments of intelligence they have, now bid for this place. We met children who [seem] ready to give it to them. These children defined themselves not with respect to their differences from animals, but by how they differed from computers. Where we once were rational animals, now we are feeling computers, emotional machines . . . probably the challenge of the computer will inspire them [children] to invent new hybrid self-images, built up out of the materials of animal, mind, and machine."[21]

Memory: Changing with Technologies and Time

In his book on the history of discovery and invention, *The Discoverers*, historian Daniel J. Boorstin describes the effects of technology and social change on a key aspect of man's mind and reality: memory. Its role, he reminds us, changes with the changing perspectives of history. "In his dialogue with Phaedrus . . . Socrates recounts how Thoth, the Egyptian god who invented letters, had misjudged the effect of his invention. Thoth was thus reproached by the God Thamus, then King of Egypt:

> *This discovery of yours will create forgetfulness in the learners' souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves. The specific which you have discovered is an aid not to memory, but to reminiscence, and you give your disciples not truth, but only the semblance of truth; they will be hearers of many things and will have learned nothing; they will appear to be omniscient and will generally know nothing; they will be tiresome company, having the show of wisdom without the reality.*"

With print technology, comments Boorstin, the effects on memory were multiplied many times over, and the differences between the memory and thinking of people in an oral world became profound. Furthermore, he points out, the role of memory not only declined, but perceptions of it changed. Indeed, "the founders of modern psychology were increasingly interested in forgetting as a process in everyday life," he notes and cites William James's comment on life in an age of increasing information: "'In the practical use of our intellect,' James said (long before home computers, television, and satellites were reality), 'forgetting is as important a function as remembering. . . . If we remembered everything, we should on most occasions be as ill off as if we remembered nothing.'" Thus, says Boorstin, "In a century when the stock of human knowledge and of collective memories would be multiplied, recorded, and diffused as never before, forgetting would become more than ever a prerequisite for sanity."

Children are changing before our eyes. It is still their mission to learn and grow, but it is clear they will do so in a different way, a way that reflects their experience and perception of the world around them. Schools—and teachers—can hope to meet the learning needs of these contemporary learners only if they are willing to understand and respond to what is new and different in their students.

This viewpoint poses special challenges for today's educators. Even though many teachers are themselves members of the television and computer age, the training they receive and the context in which they teach are influenced by the values of an earlier time. The traditional print-oriented training that teachers bring to the classroom thus runs head-on into a student body whose perspectives, needs, and thoughts are fundamentally different.

Caught up in the frustration of trying to teach old ways of thinking to new kinds of thinkers, teachers may easily lose sight of the positive aspects of change. In our increasingly fast-paced, complex, and interdependent world, we will need the skills children are acquiring to process information quickly from many sources. We will need to rely on their greater independence and fearlessness. We will need their flexibility and creative initiative. Thus, in the effort to address the intellectual gaps promoted by the new technology, it will be important also to nurture the strengths.

It would be a mistake, indeed, to underestimate the positive characteristics of today's learners. Like their predecessors, they are wonderfully inventive and creative young people, with unlimited capacity to learn and grow. But it is clear that they will do so differently, and programs will benefit students only if they are designed with full appreciation of what is different about these youngsters. As this is accomplished, the very special characteristics of high-tech learning—emphasis on speed, visualization, interactivity, and flexibility, to name a few—may prove to be marvelous servants since they share the hallmarks of contemporary media.

An Onslaught of Powerful Influences

It is difficult to understand the consequences of the rapid pace of change. Not long ago, values in a social group changed slowly, almost imperceptibly, over many generations. In our contemporary life, the introduction of innovative and powerful technology, such as computers, causes rapid change in beliefs and ways of thinking about things such as time and space. Today, one is challenged to make wholesale adaptations to new ideas, concepts, and values within the briefest periods of time or risk being lost within one's own culture. Making those kinds of adaptations is second nature for children, while it is often tedious, even painful, for many adults. Despite the discomfort, it is true, as one writer observed, that "the educated man of yesterday is the maladjusted and uneducated man of today and the culturally illiterate misfit of tomorrow."[1] The times, they are changing—rapidly.

1. Bentley Glass, quoted in Harold G. Shane, et al., eds., *Educating for a New Millennium: Views of 132 Influential Scholars*, p. 47

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Part II: Effective teaching in a time of change

Part II: Effective teaching in a time of change

All the talk about excellence is superficial unless we acknowledge that good teaching is at the very heart of good schools.
—Ernest Boyer

I can't seem to reach the kids anymore.
—(Explanation of a teacher preparing to leave his job after 20 years in the classroom.)

Teaching skills for a new era

A persuasive case can be made that today's children, products of different influences than are the adults around them, do not experience school as a special opportunity in their lives to learn and grow. Instead, for student and teacher alike, school often is a source of frustration or boredom. In Part I, we examined in a general way some of the reasons why. That early discussion leads naturally to a pragmatic question: how can the public school system be made more responsive to the learning needs of different kinds of students? More specifically, what attitudes, practices, and teaching styles will teachers need to change if they are to work effectively with media-age children?

Teachers have long contributed to building many different kinds of skills in their students. Yet the emphasis consistently has been on providing information on which to reach sound decisions, rather than on understanding the process of generating and evaluating options. There are many indications that this model of the past simply will not serve children in the future. The curriculum should be responsive to the strengths and limitations of today's children and their world. And of course, *practitioners cannot instruct students in the new information-age skills until they have mastered those skills themselves.*

Those skills go well beyond computer literacy. In fact, hands-on training in the use of computers, while a critical short-term concern, may, in the long term, be the least important of the "technological" skills required of teachers. Instead, the need even now is for educators skilled in providing order and meaning for students who are overburdened by factual information, in providing relevance and stimulation to learn in a fast-moving world that fosters both isolation and interdependence, and in understanding and responding to a remarkable range of learning needs in an increasingly diverse student population.

Teaching mental discipline

Although the mass communications media tend to foster superficial thinking and general disinterest in detail, the ability to keep pace mentally with the staccato rhythms of electronic society and to attend to a wide range of disparate information will serve youngsters well. The challenge to educators is to encourage the capacity to deal with many things at once *and* to motivate students to acquire the mental discipline necessary for concentrated, in-depth thought. It is unrealistic to believe that teachers can meet this new kind of thinker on common ground until and unless the teacher grasps an understanding of the differences that exist between them. Teacher preparation institutions and inservice coordinators have a central role to play to gather and share the understanding and training that will improve communications and facilitate learning.

Teaching interpersonal skills

An irony of the era is that the technological and social changes that have made the world more interdependent have contributed to a generation of children who are individually more isolated, more autonomous, and less responsive to others. Institutions such as the church and family, devoted in the past to fostering sharing, compassion, and communal cooperation, no longer provide sufficient support to counteract many different isolating influences. As a consequence, children need instruction in a basic and important skill: working and getting along with others. Teachers must first make these abilities their own before they can be shared. Preservice and inservice human relations and communications training—frankly, often considered a frill activity in the past—deserves serious consideration as a *basic* skill for both teachers and students.

Dealing with diversity

For teachers, a difficult characteristic of the newer generations is their range of abilities. Not only does each child come to school with a much broader base of knowledge, but the variety among individual students is sometimes astonishing. Furthermore, it is deceptive. Because of the shared experiences of mass media—particularly television—children often appear to be much alike. Yet for precisely the same reason—the overwhelming amount of information coming from the mass media—children respond to their world in remarkably diverse ways. The result is often a class of apparently similar youngsters whose learning styles, verbal skills, motivation, interests, and creativity may be strikingly different. It gives one pause to realize how totally at odds that reality is with existing structures and practices of schooling—from uniform grade and class groupings to promotion policies.

Teaching individuals with individual needs

Giving meaning to standard curricula and motivating youngsters of such diverse backgrounds is a formidable task. Yet children need to find personal relevance in their study and work. Often overcome by the range of information and values that confront them, students need to develop the skills to assemble that information in a coherent way. Creating relevance for students in this mix of amazing diversity requires gifted use of the full range of resources available to schools and teachers. The traditional model of one teacher, following a standard curriculum behind closed doors with 35 very different young learners, is not a formula for allocating resources that is likely to meet with great success in the future.

Skilled use of educational technologies

Teacher training is of critical concern with the coming of computer technology to the schools. Television and other communications media are a natural part of the environment for children. For many adults—especially those whose training and experiences are rooted in print-oriented values and skills (such as teachers)—the nature of the new technology may seem especially threatening. "The presence of even one computer in the classroom changes not only the physical space, but also changes the nature of control the teacher exercises."[22] Teacher acceptance of the control issue "is a profound index of acceptance, and integration, of the innovation. One teacher said she had to get used to allowing students to work on the computer and not . . . with her."[23]

On a more comprehensive level, the use of educational technology as a whole is undermined by another characteristic perceived by many teachers. "In its application of psychological principles and empirical data in the formal design of instruction, educational technology has taken upon itself an appearance of an assembly line and a machine-like mode of operation, and has adopted a language style that saps energy, imbued with a tone that is cold and impersonal."[24]

Such sentiments underscore the critical role that trained staff play in the

Interactive Media:

I hear and I forget. I see and I remember. I do and I understand.

—Chinese Proverb

Though expressed long before the computer, indeed, long before Gutenberg's revolutionary invention, that proverb sums up an important truth about educational technologies: Participation of the student in the learning process is the most potent ingredient of all. Computers and other interactive media like video games and videodiscs permit the direct involvement of the student in learning. For that reason, they are—at least potentially—the most powerful instructional tools.

Although the predominant uses of computers in schools—drill and practice—are limited and reminiscent of print technology, even these early applications reveal the advantages of the interactive electronic technologies. Chief among them are efficiency, instantaneous feedback, individualization of instruction, and student control.

Of all the positive characteristics claimed for instructional computers, the one which has been confirmed most satisfactorily by research is efficiency. Computer-assisted instruction (primarily of the drill and practice variety) has been consistently shown to result in as good or better comprehension and retention in significantly less time than traditional approaches. For example, one study of computer-assisted instruction in elementary and secondary schools reports an average increase of .41 standard deviations in achievement scores, or from the 50th to the 66th percentile. Although the study found that these results were not as great as those reported for peer and cross-age tutoring, they were far larger than effects produced by noncomputerized programmed instruction or individual learning packets.[1]

Offering Timely Reinforcement

"Behavioralists point to the importance of timely reinforcement in the learning process," writes Gary Donhardt. "While the manipulation of the microcomputer is in itself a reinforcer, the immediate feedback that can be given to the students is quite beneficial." He notes: "A response within two seconds has been shown to constitute an important boundary in the effectiveness of feedback," and computer technology, with cycle times measured in microseconds, makes such feedback possible.[2]

A number of studies have shown computer-assisted instruction to be particularly effective with disadvantaged and handicapped youngsters, perhaps because it appeals to the motivational needs of low-aptitude students in a way that conventional classroom learning does not. PLATO program, for example, is incapable of judging students on the basis of personal prejudice or according to rumor or 'reputations' that have followed them from lower grades. Some students may perceive computerized instruction as more forgiving, more patient, more consistent, and less critical than human contact. A seven-year-old put it more simply: "The computer doesn't yell." That, many educators believe, is one of the critical strengths of computer instruction, at least as it is currently used today. Error becomes something to learn from rather than to fear.

There are other distinct pluses associated with computer-assisted instruction. Computers and other electronic technologies create educational opportunities as well as provide educational tools. Because of their efficiency,

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effective and creative use of any instructional technology. Yet it is estimated that fewer than a fourth of today's classroom teachers have had any form of instruction in the use of computers, although the number of computers in the past two years made available for instructional purposes has more than doubled.[25] One review of computer-based instruction spanning two decades notes that "teachers are trained to deliver content in a group setting and are not prepared to provide individual tutoring in content delivered by a computer."[26]

So, how much and what kind of training do teachers need if they are to use computers effectively? Responses to that question vary. One study expresses the view that "if teachers have well-designed and appropriate software, very little training would be needed for the majority of teachers. The need for training may be overplayed; perhaps only two or three hours of training would be required to use computers in an entirely satisfactory manner."[27]

Given the rapid development of the technology, that viewpoint is understandable. However—and of critical importance—it ignores the need for a range of *technology-related* skills, such as "reading" and understanding images as well as words; using a variety of media effectively for instructional purposes; acquiring decision-making skills; and developing higher-level thinking skills. Most importantly, teachers will require training that broadens their concepts of teaching and learning. The best hardware and software will be of little value in the hands of a teacher whose training and experience cause him to believe that books are better instructional tools than films or that computers are "dehumanizing."

Strengths and Limitations

they help to overcome geographic and economic barriers to learning, assist in solving major logistic and operational problems—from transportation to budgeting—and already represent an important tool in special educational programs.

Understanding the Potential

These powerful new educational tools are not without drawbacks. Indeed, our understanding of their power and capabilities is so limited, and the technology is changing so rapidly, that educators may feel, very appropriately, that they are playing with fire.

The "trivial application of very sophisticated technology" is currently the source of considerable debate about the value of investment in educational computers. "There seems to be little doubt that computers can help students learn. Various programs have reported success with arithmetic and other subjects suited to rote memorization. But there is no evidence that students retain material better—or even better than if they've been drilled conventionally."[4] Along the same vein, "Why spend $2,000, or $1,200, or even $600 for an electronic workbook when a plain old $2.95 workbook with lots of drill and practice sheets will do just as well?"[5] The problem is that, with few exceptions, computer technologies are not being used appropriately. The emphasis has been almost entirely on drill and practice and tutorial applications instead of those—such as simulation and model building—to which they are more suited. With their visual capacities, infinite flexibility, and interactive nature, computers are an ideal medium for simulations and model building—activities that tend to develop higher-level thinking and inferential skills. While concluding that much more study remains to be done, experts suggest that future uses of computer technologies should focus more on these higher-level cognitive skills and less on the print-oriented skills fostered through drill and practice.

Along with studies showing computers to increase motivation, creativity, and comprehension are studies showing students' frustration, disinterest, and boredom. It is possible to generalize from both positive and negative findings, however. Consistently, the context of the computer instruction has been a key factor in the outcome. For some, computer programming (at least as it is commonly taught in schools) has been a positive, enriching experience. For others it has not. The reason for the variance, researchers suggest, has much less to do with the computer than with the instructor's understanding, the purposes for which programming skills are taught, and the child's abilities and inclinations.

1. John Condry and Douglas Keith, "Educational and Recreational Uses of Computer Technology: Computer Instruction and Video Games," pp. 96-101. James A. Kulik, "Synthesis of Research on Computer-Based Instruction," pp. 19-21.
2. Gary L. Domhardt, "Microcomputers in Education: Elements of a Computer-Based Curriculum," p. 31.
3. Condry and Keith, p. 100.
4. Joseph A. Menosky, "Computer Worship," p. 100.
5. Guy Reetz, quoted by Joseph Menosky in *Ibid.*, p. 100.

Other Sources: Henry J. Becker, *Microcomputers in the Classroom*. Bonnie Brownstein, "Computers: A New Way of Looking at Learning." Patrick J. Foley, "Learning About Computerized Instruction with Adults: One School's Trials, Errors, and Successes." Gail R. Meister, *Successful Integration of Microcomputers in an Elementary School*. Seymour Papert, *Mindstorms*. R. G. Seaborne and Roger Kaufman, *Technology in Education: Its Human Potential*. Sheingold, et al., "Microcomputer Use in Schools: Developing a Research Agenda." Ellen Wartella, *Children Communicating: Media and Development of Thought, Speech, Understanding*.

Traditional teaching and training: impediments to change

But moving from where the profession is to where many believe it needs to go is not a simple task. Of course, there are innovative practices and programs that do not fit the "traditional" schooling model and creative educators who are not at all frustrated or confounded by new technologies or "high-tech" children. We look to them to both inspire and lead. But there are far more teachers and programs bound in the lock step of tradition. It is, therefore, possible to talk about common teaching practices and the fundamental beliefs that limit the training and careers of today's teachers. We perceive four fundamental obstacles that educational leaders, we suggest, need to address:

- the limited scope—with primary emphasis on content—of contemporary teacher training,
- the limiting skills of teachers to function as learning experts in this high-tech age,
- the limited power that teachers exercise in the teaching/learning process, and
- the limiting effects of an inherently (and necessarily) conservative profession.

A narrow focus on content

Of all the forces shaping the lives of contemporary children, none is more powerful than the information explosion. From infancy, today's children are assaulted—and that may be the most accurate word—with an astounding range and volume of information. Perhaps most significantly, information is not delivered in an orderly fashion. Add to that change at an ever-accelerating pace, and the result is a generation of youngsters who, at best, are comfortable with disorder and, at worst, find little order, stability, or coherence in their lives. These children require not simply more information, but "sustained help in coping with the way in which knowledge is accumulating. . . . The graduates of our schools should be armed, insofar as possible, with information-processing skills . . . as well as knowledge of how to process quickly the enormous eruption of new informatigon which our culture provides."[28] In short, students need from their teachers guidance in making sense of their fast-moving, fragmented world.

But their teachers have been trained and are expected to present a standard body of information, not to make order and sense out of unlimited information. "Schools have been most successful at teaching factual information and fixed procedures, such as arithmetic. In the past, they were not asked to provide universal high-level intellectual preparation."[29]

Teachers are trained to be content specialists first, instructional specialists—that is, educators in the richest meaning of that word—second. Recent criticisms of a decline in content knowledge among teachers bear witness to this professional bias toward subject specialties. Reporting on a study of curriculum and training practices in teacher training institutions, one researcher concludes that "teacher preparation programs across the country . . . are characterized by their brevity. While there has been a proliferation of concerns which schools are asked to attend to and an expanded information base related to the craft of teaching, the number of hours future teachers spend in professional studies and related foundation work has not significantly increased."[30]

> ***In teaching it is the method and not the content that is the message—the drawing out, not the pumping in.***
>
> —Ashley Montague

In other words, the training of content specialists for the nation's classrooms is much the same today as it has been in the past. Fundamentally, the role of the teacher remains that of an authoritative, "expert" presenter of information in a specific subject area.

"In terms of professional preparation," the same study reports, "slightly less than 40 percent of a prospective elementary teacher's total undergraduate studies are devoted to what could be construed as professional training. Secondary school students engage in even less professional study. Less than one-fourth of . . . [a] student's undergraduate academic career is devoted to professional training and only about 10 percent to some form of supervised practice teaching."[31]

Furthermore, continuing/inservice training programs tend to confirm the pattern of subject-area specialty. Teachers are inclined to take courses that update their knowledge in their special fields, rather than to gain different kinds of instructional skills and strategies.

Limited teaching styles

Contemporary teaching style, no less than content, reflects the rather narrow constraints of print orientation. Eighty-eight percent of all teaching involves only two techniques: frontal teaching (lecturing, telling, questioning) and seatwork—both "verbal" instructional techniques—although as many as 15 other choices may be available and appropriate.[32] Furthermore, those two prevalent techniques may well be the least effective in motivating students — particularly youngsters oriented to television and other visual media. "The lecture system," comments one educator, "encourages a static, passive attitude toward education that emphasizes memorization instead of the active, inquiring cast of mind required to keep up in a rapidly changing field."[33]

Despite its limitations, this consistency of style pervades the profession. John Goodlad found, for example, that even teachers who had as few as five students in a classroom were teaching just like teachers with 35 pupils, and their pupils were all equally passive. "Can high-level skills, cooperation or problem-solving be learned in classrooms where the students are primarily passive?" Goodlad asks. And he responds, "I think not."[34]

Many fault teacher training programs for the limitations observed in teaching practices. "I am forced to conclude," says Goodlad, "that the professional education of teachers is simply not sufficient for them to transcend the conventional wisdom and practices of their calling. We provide teachers with a reasonably well-developed language of what good teaching is, but we fail to give them the depth and breadth of professional, clinical experience required to translate this language into functioning reality."[35]

Says another researcher: "Teacher education as it is currently practiced in the United States—a four-year baccalaureate enterprise—is attempting to accomplish the impossible."[36] He notes the impressive and growing body of knowledge about learning, teaching, and the changing nature of childhood and laments the lack of evidence of that understanding in the day-to-day practice of teaching.

Characteristic of the profession's tenacity in holding onto established practices is the fact that "for years teachers have been told not to lecture to adolescents, while they as future teachers are being taught by the lecture method."[37] Further, "human relations training in teacher education programs is still not common even though. . .the potential utility of such training in a highly interpersonal endeavor such as teaching has been amply documented."[38]

But it would be unfair to suggest that teacher training programs or the teaching profession bear full responsibility for the limitations of current teaching styles. Teacher training and teaching styles are wholly consistent with a system of schooling that has remained "impervious . . . to . . . [reforms] for nearly a century. What few changes occurred in curricular content, classroom talk, and the formal recitation were overshadowed by the persistent continuity of teaching practices extending back decades into the shadows of a previous century."[39] Those teaching practices, like the schools, were and remain rooted in print technology and its emphasis on verbal instruction, rote learning, and fixed, sequential content.

Unchanging Style

"Essentially, because there have been so few quantum leaps in educational work efficiencies, my school uses the same teaching process that has been followed for 50 years. There are a few frills, such as overhead projectors, record players, and an occasional movie, but the instructional process is basically the same as it has been since the invention of the printing press 500 years ago. If we were to remove the books from the school, the process would be the same one we have known for all of recorded history. Thus, except for the printing press that allows a teacher to leverage his work into a portable and permanent form that others can work with without his presence, education has been almost totally stagnant in work improvement strategies from the inception of recorded history."

—Dustin Heuston
An English Teacher's Conversion to Technology

Disempowered educators

One of the most striking characteristics of the teaching profession today is its limited involvement in the educational decision-making process. Granted considerable autonomy behind closed classroom doors, teachers have virtually no voice in most of the critical decisions affecting learning: the selection of teaching tools and materials, the determination of the use of study time, the measurement of student success, or the establishment of learning goals (see box). There is a representative role in these areas, to be sure. However, while teachers may sit on textbook committees, they do not select texts; boards of education (often at the state level) do. While teachers may comment on the use of school time, they do not establish the length of the school day or the school year or even class periods.

Furthermore, schools increasingly seek to "compensate for teachers' lack of competence through technical control over the processes and outcomes of instruction. Such technical control has commonly included the use of tests to insure accountability, the development of 'teacher-proof' curriculum materials, the creation of instructional management systems, competency-based teacher education, management by objectives, and the like."[40]

The learning results for students have been uneven; the consequences for teachers have been particularly damaging. "Instead of policies aimed at encouraging active commitment to high academic standards, we have legislation aimed at standardizing instruction and at holding teachers accountable for developing students' skills to certain minimum levels. . . . In defending the public against incompetence, regulatory policies demean the occupation of teaching and further erode its attractiveness. . . . The implicit message of many public policies directed at teachers is clear: 'We don't trust you; we have little confidence in your competence; we are going to scrutinize you carefully and, wherever possible, constrain your discretionary behavior with rules, prescriptions, systems, technology, and administration.'"[41]

Teachers' lack of decision-making authority has important implications for the profession, both long- and short-term. It has, for one thing, contributed to a stressful relationship between those who make the instructional choices (curriculum designers, administrators) and those who implement them (teachers). As one teacher who serves in both capacities describes it: "As a teacher, I do very little detailed planning, close my classroom doors, put on a performance, react emotionally to my students, feel that the teacher knows best, seldom use packaged materials, and—when I do—modify them beyond recognition. As an instructional designer, I plan obsessively, treat the teacher as another module or medium, emphasize criterion-referenced effectiveness, discourage even trivial variations, and feel that teachers do not know what is good for them."[42]

The systematic disempowerment of teachers has been an evolutionary process, participated in by teachers, administrators, and the public alike. Its roots are embedded in good intentions: to meet important schooling goals and to maintain schooling decisions in the hands of lay boards of education, an important principle in our democratic society. Similarly, standards for curriculum are set to assure quality, equity, and efficiency in the schools.

The consequence of these choices, however, is an educational process that conflicts with the needs of contemporary children and youth. Because they are a highly diverse group, children need, for example, highly individualized instruction, which is difficult to provide in a standardized system. Because of the volume of information with which they must deal, youngsters need more help in using information and less emphasis on recalling it. This is an elusive learning goal in a system that measures success in terms of the acquisition of content. Because teachers must defer most critical educational decisions to an agreed-upon, standard instructional program, they are neither empowered nor prepared to aid students in acquiring the new skills demanded by the "information age." Nor do they now have opportunities to assume the roles that an adjusted curriculum demands of its teachers.

Instructional Decisions: Who Makes Them?

"Consider . . .what basic decisions directly affecting instruction were sealed off for decades from teachers:

1. How many and which students should be in the class?
2. Which students should leave the class because they are not profiting from instruction?
3. What extra instructional help will students get?
4. How long should the school day or class period be?
5. Should teachers have planning time in the daily schedule and, if so, when?
6. What texts will be used for each subject?
7. What grades or subjects will each teacher teach?
8. What should be the format and content of the report card?
9. What standardized tests will be given?
10. What content will the teacher teach?

The results of these decisions, nested in a structure outside the classroom, established the context for what teachers did in their classrooms."

—Larry Cuban
How Teachers Taught: Constancy and Change in American Classrooms 1890-1980

An inherently conservative profession

A profile of today's public school teacher reflects the traditional nature of the profession and establishes the link with the print-dominated beliefs and goals of the last century. More than a fourth of those teaching today were teaching twenty years ago; two-thirds have from five to nineteen years of experience. Fewer than eight percent have been hired in the last five years. Their average age is forty. Three-fourths are married, and nearly that many (70 percent) are women. Although larger numbers of teachers are leaving the profession before retirement age than in the past, at least half of those now teaching expect to stay in the classroom until retirement.[43]

More to the point is the conservative nature of teaching practices. "We must never underestimate the extraordinary stability and resistance to change of pedagogical procedures," warns John Goodlad. "Teachers teach very much as they were taught using materials very much like those through which they learned while students in schools. Overwhelmingly, they and not their students take the initiative. There is little praise, little correction with feedback, little laughter, little anger, little overt emotionality of any kind."[44]

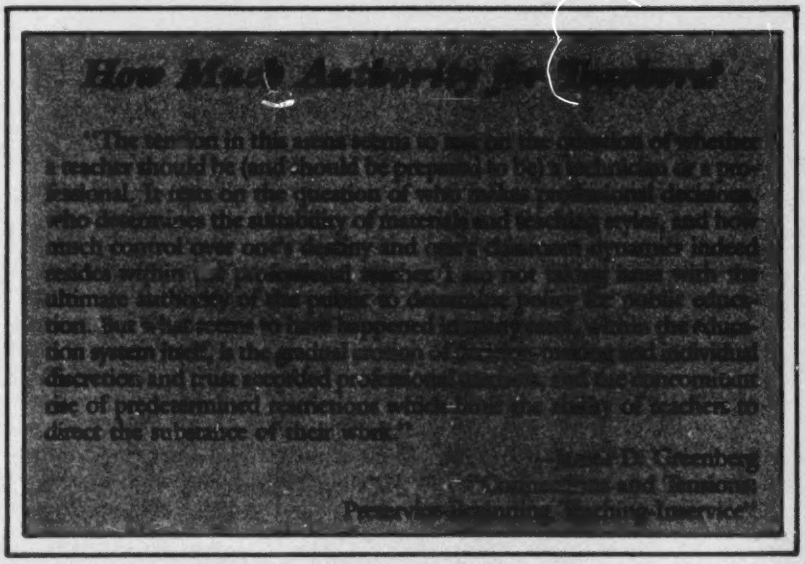
Some of the current efforts to introduce computers to schools—as with prior efforts to use innovative practices—reflect the resistance of the profession to change, innovation, and new responsibilities. "The teaching profession is constitutionally conservative, and for good reason. It has fallen for educational quackery in the past and is reluctant to do so again."[45] But the resistance to computer technology is particularly marked because "teachers do not want their jobs usurped, and since most [computer] programs do aim to mimic human teaching activities, this is an understandable fear."[46] Furthermore, "teachers do not want their normal routines disrupted by, for example, the need to be responsible for the security and scheduling of the use of computer resources."

Even where computers have been successfully introduced into schools, teachers are cautious in their acceptance. "It was clear that the teachers were most concerned about the possible effects of two things: their own autonomy and their own interaction with students."[47]

The nature of the new technology may also contribute to a further sense of powerlessness and thus to resistance among teachers. It requires a certain amount of know-how just to turn the computer on, let alone to use it effectively for teaching. Often students are more familiar with the equipment and procedures than are teachers. It is not surprising, therefore, to hear prophets of failure for computer-aided instruction. Indeed, if steps are not taken to address important reasons for resistance, these prophets may be proven correct.

There is an interesting exception to this pattern of uninvolvement and resistance to the use of instructional computers. It is worth noting because it so aptly characterizes the relationships of teachers, change, and decision making. In the early stages of the introduction of educational computers (a stage still continuing in many states), teachers have had nearly unilateral power and responsibility in a range of decisions relating to computer use. A recent survey shows that at the elementary level, at least 20 percent, and as many as 42 percent, of the selections of hardware and software and decisions about their use were made by a single teacher. (At the secondary level, the percentages of single-teacher decisions are higher.)[48]

But characteristically, this pattern already is changing. As concerns about appropriate software, computer literacy, and equipment compatibility increase, local, regional, and state policies develop to assure standards of quality, equity, and efficiency. Selection of equipment and materials is quickly leaving the hands of individual teachers, reverting to committees, often at the state level. It is not our purpose to criticize that movement. The point is simply that the existing model, which leaves instructional decisions to systems rather than teachers, is firmly established, and there do not yet appear to be alternatives to permit or encourage shared decision making.



Challenges to the teacher's traditional role

Long revered as experts, teachers increasingly find themselves in a highly competitive position as providers of information. Unless they (and the public) are willing to change that perception and practice, teachers-as-information-sources may well assume a secondary role in the teaching/learning process.

External influences on the teacher's role

A number of complicating forces test the efficacy of traditional teaching/learning patterns. School walls are beginning to disappear. It may be the case that the formal educational system's antagonism to technology will force computer-assisted learning into a role outside the school and university, some observers believe. This view neglects an important point: Multidimensional, multisource learning already is occurring. Over 48 million adults attended some type of education program in 1980; only 12 million were in programs in colleges and universities. Business and industry expenditures for education grew from approximately $2 billion in 1977 to close to $10 billion in 1980. Other estimates, such as those of the American Society for Training and Development, put the expenditure at closer to $30 billion. While all but a tiny percentage of those dollars support adult education, the time may be approaching when business and industry become more intimately involved with elementary and secondary schooling. As a result, money and involvement from the private sector will help shape more directly the goals and structures of schools, reflecting the objectives and priorities of the funders.

In another area, computer and software manufacturers face a crossroads with respect to instructional computing. Their choices can have great impact on the future of schooling. The school market is regarded as a poor prospect for the computer industry. Educational software is expensive to create—especially good software—and piracy in the schools is a major problem. In contrast, the lucrative home market is in many ways more attractive. It is easier to reach and easier to write for (standards aren't as high for a noneducator audience), and piracy isn't a major concern. One possible outcome of these market considerations would be to have the resources and energies of software manufacturers targeting the home for educational and entertainment products, and so bypassing the professional understanding of how and when children most appropriately learn.

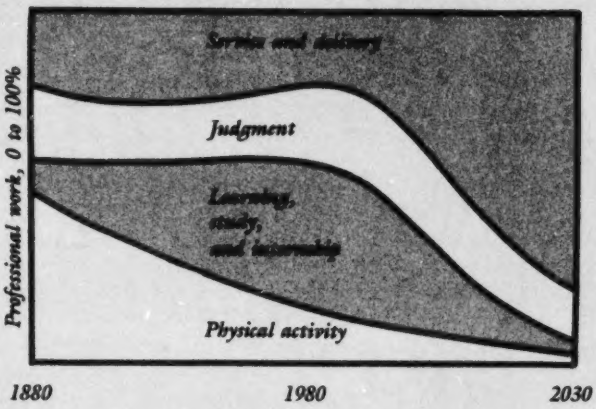
> *The ultimate goal of an educational system is to shift to the individual the burden of pursuing his own education. This will not be a widely shared pursuit until we get over our old conviction that education is what goes on in school buildings and nowhere else.*
>
> —*John W. Gardner*

Information sources outside the school

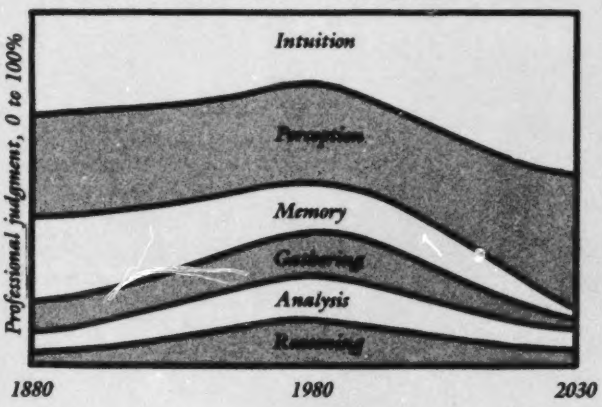
Many information sources for a growing number of children are outside the school. Television, radio, and film are primary among such media, but computer networks and data banks, satellite communications, community library/information services, and the like are expanding daily the choices available. Dispensing information is only one function of these technologies. Formal instruction is available in an increasing variety of ways, from Sunrise Semester to home tutoring. Formal credit for diplomas or degrees is often available from nontraditional sources.

The expansion of learning opportunities has implications for teachers. It deemphasizes the teacher's role as a primary source of information and threatens his reputation as an authority. The growing availability of alternative sources of instruction means a further diminishing of control by teachers and schools over the learning process. The many standards established to ensure quality and equitable instruction lose relevance as new learning options appear. Since a primary task of teachers has been to implement standardized programs and policies, their work loses relevance as well. How, in the mid- to long-term, the question of standards will be resolved remains to be seen. It does seem clear, however, that a shift to more flexible standards will be necessary. And reasonably, that flexibility will be reflected not only in the way schools and teachers treat a certificate from a trade school or a computer correspondence course, but in the way teachers manage their day-to-day instructional tasks. Indeed, it may be appropriate to suggest that the teacher's role expand to provide guidance and order for each youngster's *total* learning experience.

Changing constitution of professional work



Changing constitution of professional judgment



Source: Frederick Hayes-Roth, "The Machine as Partner of the New Professional," *Spectrum* (June 1984): 28-31.

The Professional and the Computer

"Electrotechnology has wrought great changes in the way that professionals fulfill their various roles," Frederick Hayes-Roth points out in two telling graphs. The first "offers an estimate of how four principal components of the professional's work have shifted in the past and will shift in the future. . . . But [computerized] knowledge systems should soon begin to assume much of the burden of memorization and information retrieval, leading to a steady decline in the duration of training. . . .

"The only major component of professionals' work that I believe has not changed and will not change substantially," Hayes-Roth continues, "is judgment, which might be seen as the constant by which professions are defined." However, as his second graph shows, "the capabilities which comprise professional judgment change over time. Largely in response to the enormous growth of information generated by electrotechnology, professionals today need a balanced mix of capabilities in order to perform effectively. In the future I expect knowledge systems to reduce the time a professional will need to spend in memorization, gathering, analysis, and reasoning to reach useful judgments. However, intuition and perception, two distinctively human skills, will become more and more important, especially in proportion to other skills."

—Frederick Hayes-Roth
"The Machine as Partner of the New Professional"

Shifting professional standards

Alternative learning sources attack the isolation of schools and the isolation and exclusivity of teachers as a profession. It may be necessary to reexamine notions about certification to reflect changing ideas about who is qualified to teach and what skills are required of instructors. There is, as a matter of fact, evidence of an increasing use of noncertified persons in the schools. In some cases, this simply means using specialists in subject areas where certified staff are in short supply—in math and science, for example. But other school systems are encouraging noncertified instructors to participate in the schools on a regular basis. Volunteers form a key part of many instructional programs, as do professionals in businesses through Adopt-a-School programs. In a number of states, special certification standards permit a wide range of professionals in the classroom if they have valuable skills or information to share.

However innovative, most of these alternative learning sources continue to reflect a traditional concept of teaching: instruction is a matter of *conveying information*. There is, therefore, a risk that instead of fashioning a new role for teachers, the future will bring a diminished (but similar) role as they are replaced by more efficient information media. Human contact, the creative interchange of ideas, the spark of spontaneity—all so critically important to quality education—could be lost or seriously diminished in the array of choices people will have for acquiring information.

One educator sums up the prospects: *"The challenge is simply to see if teachers can and will change from disseminators of knowledge to collaborators in learning."*[29] (emphasis added)

All of these developments create complex and difficult challenges for the teaching profession. The changing nature and needs of children and of a technological society will certainly benefit from a change in roles and responsibilities for teachers. To be responsive, the profession must shift its energy and its focus from "information" to "formation." No longer merely executors of a standard, homogenized curriculum, teachers will need to play a more creative and responsible role in guiding children's intellectual and social growth.

The irony is that teachers are not prepared—by training, practice, or the structures and beliefs of the profession—to assume such responsibilities. Furthermore, their lack of authority and responsibility in the decision-making process produces resistance to such changes.

The profession (and public) must therefore consider whether teachers are to be technicians or educators. The essential issue has to do with authority and responsibility. Will key instructional decisions continue to be made by systems, in the name of standards and equity, or will teachers be empowered to make the creative and individual instructional choices required by today's technological society?

Empowerment requires not merely authority, but training as well. Teachers must be *prepared* to assume new responsibilities—with skills appropriate to the task. The changing child and her technological world require teachers with special capacities. These include not simply subject matter expertise, but an understanding of a wide range of data sources and skill in using and ordering information; an understanding of the uses (and misuses) of various instructional media and the skill to apply them to individual instructional programs; and strong communications and interpersonal skills plus the ability to share these with their students.

To achieve this level of authority and trust, teachers must redefine their role during a time of dramatic change—admittedly no easy task. If they continue to serve primarily as sources of information to their students, they will find themselves, at best, with strong competition. At worst, they will be obsolete, because the numbers and capabilities of "teachers" of all kinds—from television to data banks to industry—grow daily.

There is another role for teachers to play. As "master teachers," if we may suggest a new slant on this term, they may serve best if they are trained to help children deal with the many, often confusing sources of information in their worlds. By assisting students to coordinate information, to use and understand many sources of information, and to make well-informed decisions, teachers would draw on a wide range of "teachers" in the lives of children. It is both opportunity and challenge to redefine a profession, to become expert brokers of the principal commodity in the information age, and, in the process, to work collaboratively with industry, with private educational sources, with the home,

Cultural Tensions

"If we acknowledge diversity and the presence of newcomers, we have also to acknowledge the existence of tensions or dissonances between the cultures of many students and the so-called "official" culture. . . . It is evident. . .that what is in many senses 'given' to certain educated, well-socialized, perhaps privileged groups in our society does not come easily to young people from other backgrounds whose lived lives and whose family lives are different in many, often overlooked ways. There are styles of thinking, ways of talking, funds of meaning transmitted by families who are newcomers to the mainstream that cannot mediate what is taught in school—including the symbol systems we often take for granted as the only ways of thematizing a complex world. Not only is there a danger of further alienating such students by a lack of attention to what they live and what they know; there is a continual danger in the tendency to disconfirm their experiences and responses—because they do not participate in what we conceive to be 'literate' discourse, because they do not value what we take for granted as valuable. Surely, it ought to be one of the responsibilities of teacher educators to acquaint teachers-to-be with sociological and demographic realities, even as it ought to be one of their responsibilities to enable people to attend, to try—now and then—to perceive what is taken for granted through others' eyes.

"Equally important is the need to attend to the ways in which popular culture, including television programs and popular music and films, structures many young people's experience—fragments it, highlights it, offers symbols with which to represent it. For great numbers of young people today, the sounds of rock, the dizzying images of video, the bursts of pictured violence overlay and permeate their lived realities. They live, very often, bombarded with shards of sound and imagery, particles of information, slivers of news; and we who are teacher educators have to be aware of this even as we try to make available the sets of know-how that are so important in learning, even as we try to make visible and audible a more coherent, integrated world."

—Maxine Greene
"Perspectives and Visions:
Rationale for 'Foundations'
in Teacher Education"

and with and through the communications technology that is such a central part of their students' lives.

Teaching practices—and training—evolve to address specific goals of schools. Those goals in the past have emphasized the acquisition of information, the mastery of basic literacy and numeracy skills, and standardized, rote intellectual skills. Society—"consumer" of education's "products"—has clearly set this agenda. Higher-level thinking and interpersonal relations skills have not—by and large—been priorities of the schools and thus have been addressed only marginally by training and teaching practices.

But the schools' environment, the children, and the needs of society are changing and so, therefore, are the goals. The tensions in the profession may be attributed at least in part to an evolving agenda for schools that is in conflict with current beliefs and practices. In a world in which the information and knowledge base doubles in a matter of years rather than centuries, a new assignment emerges for schools and teachers. The well-educated future citizen will need to be adept at selecting information, reasoning abstractly, solving problems, and learning independently. She will also require the flexibility and the communications and interpersonal skills to permit her to function comfortably in a free-flowing, interdependent "global village."

Developing new skills, assuming new responsibilities, and defining new roles for teachers seem to be the inescapable agenda for education and teachers in the years immediately ahead. Public education's success, both in meeting children's needs and in effectively using new technologies, will depend on how completely these challenges are met.

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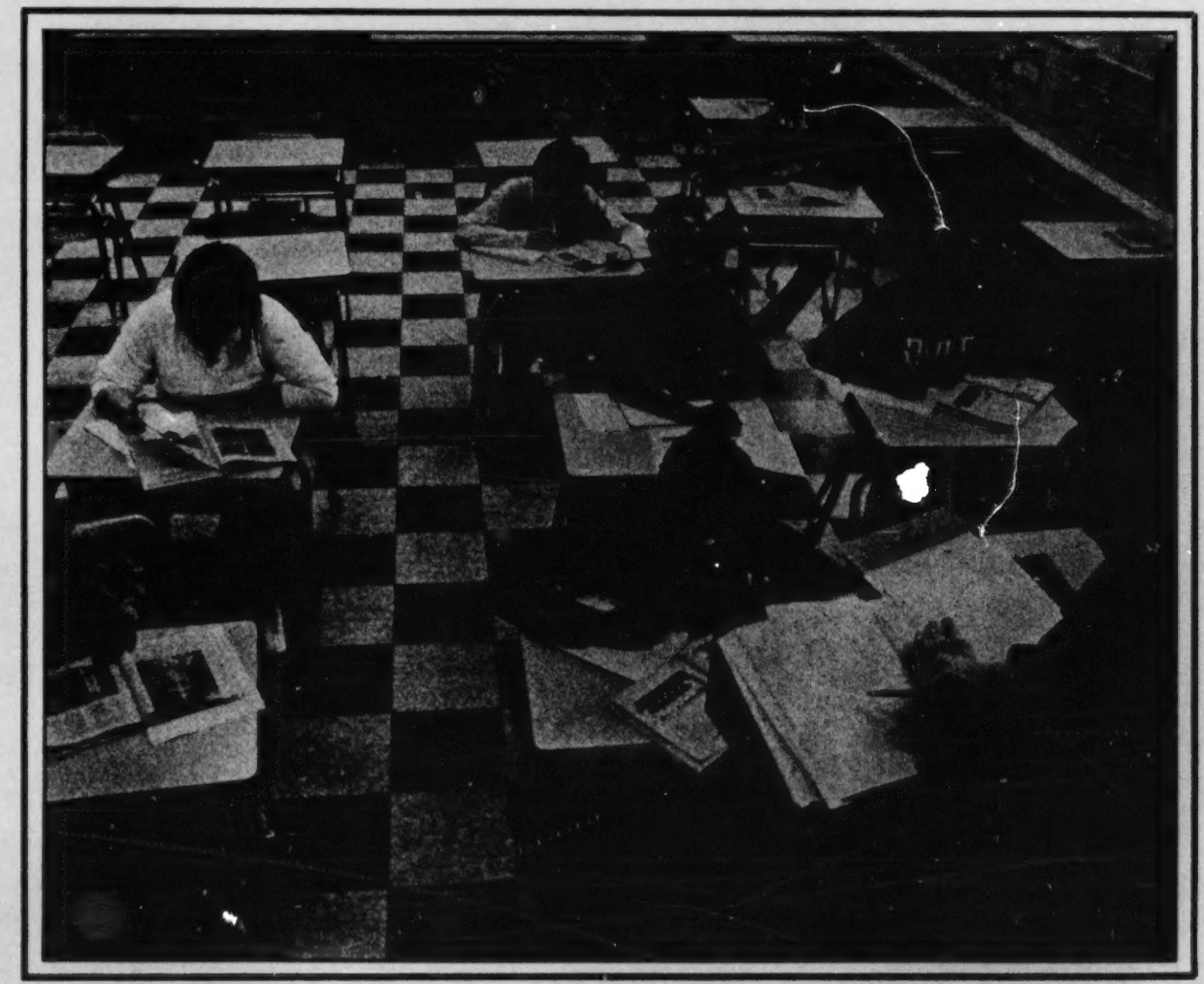
We suggest, in sum, that change is desirable, and probably necessary, if teachers are to work effectively with today's children. The first change is one of beliefs—about what teachers are supposed to do, about what they are supposed to teach, and about how they're supposed to teach it. We need to permit ourselves to consider the possibility that it may be just as important for a child to be able to evaluate information presented on television as it is to do long division; that learning to share power and responsibility with others may be as much a basic skill as traditional literacy.



Part III: Change: a process, not an event

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Part III: Change: a process, not an event

From-the-ground-up makes good sense for building ... beware of from-the-top down.

—Frank Lloyd Wright

The edifice of education is never done; it is constantly undergoing revision and reconstruction. Because that is true, Wright's admonition has special relevance for educators. Building from the ground up really does make sense.

In early sections of this publication, we have suggested that there exists a fundamental mismatch between the characteristics—and therefore learning needs—of students and the attitudes, beliefs, and training of teachers who are expected to motivate students to learn. Certainly it is not a question of who is "right" and who is "wrong." It is a question of thoughtfully assessing what is happening to students and society—and to the institution of public schooling that exists to serve them—and then correcting problems and strengthening programs. Preferably, from the ground up.

Education leaders do not need rhetoric to solve problems; they need practical ideas. Philosophical waxings on utopian solutions aren't very helpful at a time when pressure is building to intensify basic skills instruction, to adopt "computer literacy" requirements (though most people are having trouble defining what it is), and to do more with less. Perhaps most of all, we believe educators need bridges—ways of getting from here to there that make sense, seem safe, and offer a good prospect for success.

This final section is about bridges. It seeks to accomplish three things: to share a few ideas about change and success that have been gleaned from a rather exhaustive review of the research literature; to talk briefly about a few "bridges" in education that are already in place; and, finally, to summarize the arguments and viewpoints presented in this work.

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The literature that seeks to further understanding of the process of change would fill a small library.[50] It reveals that scholars and practitioners are moving toward a shared understanding of the nature and characteristics of success and failure—the positive and negative manifestations of change. Despite barriers, impediments, resistance, and assorted hurdles, positive, productive change is possible. It happens to us or around us all of the time, of course. The question is: Why and how?

Creating an environment for success

While the change literature is filled with tales of education reforms run aground (see boxes), it also reports the good news: ideas and programs that work. We found no magic wands, no panaceas, and no sure-fire formulas for success. But what the literature does reveal are a number of ideas and approaches that consistently bear positive results in the education setting. They are relevant to programs old, new, and yet-to-come. These time-tested, good ideas ask only that educators:

• ***Strive for collective understanding and endorsement of goals, purposes, and meaning.*** An expert on change emphasizes that point when he writes: "One of the most fundamental problems in education today is that people do not have a clear, coherent sense of *meaning* about what educational change is for, what it is, and how it proceeds. Thus, there is much faddism, superficiality, confusion, failure of change programs, unwarranted and misdirected resistance, and misunderstood reforms. What we need is a more coherent picture that people who are involved in or affected by educational change can use to *make sense* of what they and others are doing."[51]

Educators who succeed recognize that it simply does not make sense to give support to an idea unless, first, it's clearly understood, and second, it promises some benefit for the parties involved.

• ***Empower those affected by change.*** People need to influence decisions that affect their destinies and, therefore, need permission to discuss, interact, argue, debate, influence, and in other ways experience their power. As their sense of value and self-worth increases as a consequence of such treatment, so will their skills and professional behavior.[52] If denied such opportunity, they will focus their energy—actively or passively—to resist change.

• ***Provide opportunities for collaboration and teamwork.*** Change happens on the individual level or not at all. Teachers need support to engage in change with enthusiasm and commitment. Change involves resocialization, and, in that process, teacher-teacher relationships are important. Interaction is the basis for social learning. Closely related are "collegiality, open communication, trust, support and help, interaction, and morale."[53] Although teachers need to participate in skill-training workshops, they also need opportunities for one-to-one and group sessions to receive and give help and to come to understand the process and meaning of change more thoroughly. Furthermore, this understanding must be undergirded by concurrent changes in administrative support structures and reward systems if change is to last.

Bluntly put, the profession's cherished tradition of isolating the teacher in the classroom is a limiting choice at a time when open-ended, multiple approaches to learning work better and are probably necessary if the job is to be done well.

• ***Employ effective training methods.*** Experience shows that *pre-implementation training does not work*—even when intensive sessions are used to orient people to new programs, such as computer-assisted instruction. "One-shot workshops prior to and even during implementation are not very helpful. Teachers say they learn best from other teachers, but research shows they interact with each other very infrequently. Teachers say they need direct outside help, if it is prac-

System Resistance: An Environment for Failure

In terms of innovation, reform, and positive change, today's schools foster an environment more likely to breed failure than success. Forces to maintain the status quo in schools are far greater than those usually mustered for innovation and change. Pressures of time, inflexible systems, and shortage of resources clearly seem to limit opportunities for creative exploration of alternatives in the teaching-learning process. When change is imposed from outside the school, which is frequently the case, it is often resented. Research indicates that "there is a strong tendency for people to adjust to the 'near occasion' of change, by changing as little as possible—either assimilating or abandoning changes which they have initially been willing to try, or fighting or ignoring imposed change."[1] A school system, for example, may have access to microcomputers, but use them only a few minutes each day for drill-and-practice activities. On one level, staff have embraced the new technology by accepting computers into the learning environment—but they have in fact resisted it by sharply limiting its use.

1. Michael Fullan, *The Meaning of Educational Change*, p. 29.

tical and concrete—and they find those qualities to be the exception rather than the rule. Researchers say concrete and skill-specific training is effective, but only for the short-run. *Most forms of inservice training are not designed to provide ongoing, interactive, cumulative learning to develop new conceptions, skills and behavior. Failure to realize that there is a need for inservice work during implementation is a common problem.*"[34] (emphasis added).

• ***Share resources. Strive for balance. Understand and use the strengths of many different learning techniques.*** A truth of our time is that few individuals can encompass anywhere near the range of skills that teachers as a group must bring to bear on contemporary instructional challenges. There must be teamwork; there must be efficient ways of sharing skills and resources to solve problems. Technology—for example, through satellite learning—offers ways of doing this. But the concept of teamwork and sharing of resources is relevant in all aspects of the teaching/learning situation, to extend and vary opportunities for students.

At the same time, striving for balance does not suggest using computers for instruction *instead of* print. A theme that is reinforced in the reform literature is the efficacy of an approach to learning that employs the strengths of many different media, because students respond to learning opportunities in many different ways. Such an approach moves away from curricula, systems, and standards that are linear and fixed and unique and moves toward systems and standards and structural approaches that are variable and various in nature.

• ***Emphasize that interpersonal and group process training—for students, teachers, and administrators—is a survival skill of our times.*** New concepts of time and space, changes in the work place, the need for interaction among learners of all ages, the fundamental social nature of the species—these and many other influences support the need for this type of training. Researchers argue that such training belongs in our schools on every grade level, in inservice and staff development programs for teachers and administrators, as a component in parent-school interactions, and—perhaps most effectively—as part of the curriculum in our teacher-training institutions.

• ***Design a system to accommodate diversity.*** Schooling today pursues specific, shared, narrow, and uniform goals and practices, and it presumes the same kind of methods to be effective in achieving them. It also presumes—not in thought, perhaps, but in action—a homogeneous student body: that is, everybody needs the same thing, everybody acquires it the same way, and the "raw material" with which educators work is virtually the same.

Despite their universal application, those assumptions have never been true, and they are even less so now than a few years ago. An important theme in the changing elements of schooling is that diversity is a given, and there must be systems to address

Failure Factors

Overall, the research reveals that when educational reforms languish and fail, several factors are invariably at work: the proposed change is based on faulty and/or overly abstract theories not related to classroom practice; there is limited contact, if any, with the schools by those proposing change; although initial reception—and change—may be positive, there is a failure to follow through with continued support, funds, and training; and, most important, proposed reforms fail to consider explicitly their relationship to and impact on the purposes of schools.

Source: Michael Fullan, *The Meaning of Educational Change*

Individual Resistance: A Fear of Change

"Neglect of how people actually experience change, as distinct from how it might have been intended, is at the heart of the spectacular lack of success of most social reforms," writes Michael Fullan in his book, *The Meaning of Educational Change*. Teachers considering the history of educational reform (and their role in it) report that student benefit and procedural clarity are often low, and personal costs—to students and teachers—are high. "There is a strong tendency to oversell innovations in order to obtain funding. The gap between the benefits promised and those received is usually very large. The difficulty of learning new skills and behavior and unlearning old ones is vastly underestimated. Changes in educational beliefs, teaching styles, and other practices represent profound changes affecting the teacher's professional self-definition."

Prescriptions for Failure

The purpose of change and how it is planned and introduced are critical factors. In 1976, a survey of 679 principals in all U.S. cities with 300,000 or more people[1] sought to learn about the motivation for and success of educational change. The findings were disturbing: 1) the publicity value of innovations and faddism was among major reasons for the adoption of new programs; 2) one-fourth of the schools adopted many innovations, but, judged by a panel of experts, few were of relatively high quality; 3) cost was not a barrier to adoption (the two were *positively* correlated); 4) cost was inversely related to quality—the more costly the innovation, the lower the quality. Consistent with this study is another finding that "one of the main consequences of introducing innovations in schools is career advancement for the sponsor and subsequent failed implementation of the innovation."[2]

1. M. Nelson and S. Yoder, "Innovations in Urban Secondary Schools," pp. 213-21.
2. Michael Fullan, *The Meaning of Educational Change*, p. 16.

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that diversity, not only in the student body, but in goals and methodologies. There must be ways of addressing the fact that one student will need very different kinds of teaching from another student and that uniform goals are frequently misused.

Technology can foster diversity and offer a means of accommodating it. The relation of tutor to student throughout history tacitly acknowledges the special benefits of individual, high-interaction education. Computers offer an opportunity for the entire system to move from broad, often vague goal statements to programs designed to help *individual* students learn and grow. Realizing this potential will require a commitment to fundamental change by public and professionals alike; it cannot be achieved by the schools and/or the teaching profession alone.

The Power of Occupational Identity

For many, the prospect of acquiring different learning styles to cope with this invasion of technology makes them feel threatened and vulnerable. "Occupational identity represents the accumulated wisdom of how to handle the job, derived from their own experience and the experience of all who have had the job before or share it with them. Change threatens to invalidate this experience, robbing them of the skills they have learned and confusing their purposes. . . ."[1]

Under the circumstances, "it would be entirely possible to put *millions* of computers in the schools without producing any real change in education."[2] Practitioners will *really* change—attitudes, beliefs, techniques, and methodology—when they believe it is both beneficial and important, to themselves and to their students, to do so.

1. P. Marris (1975), quoted in Michael Fullan, *The Meaning of Educational Change*, p. 29.
2. George Leonard, "The Great School Reform Hoax," p. 81.

The "bridges" now in place

For many years, educators have been working with great energy—and sometimes, with considerable success—to understand and incorporate meaningful reform in the schools. It would be impossible to find a single model or system—amidst the amazing diversity that exists in public education—that addresses in creative and effective ways the many different concerns that relate to teaching, learning, and the new technology, if for no other reason than that *all* existing reforms are themselves rooted in print-oriented institutions.

Nonetheless, there are a number of models that incorporate features that we believe educators can study with considerable benefit since they include characteristics which are consistent with and supportive of the learning styles of today's students. As educators confront the rapidly increasing necessity to modify delivery systems, they may find in these models qualities and characteristics which, if shaped to address the changing needs of children, can serve as bridges to tomorrow's teaching/learning processes. Five such models are explored here. Each possesses qualities that provide the context for reform that may succeed in high-tech society:

- The programs are without exception different from the normal staffing/learning patterns found in public education, exemplifying a spirit of discovery and experimentation.
- Flexibility in attitudes, planning, programming, and delivery of services is a hallmark of some of these efforts.
- These activities have gained a measure of acceptance and support in the school community since they have demonstrated success in helping children learn.
- They address one or more of the elements of positive and meaningful reform that are summarized in these pages.

These models include:

"Effective schools" research

Over the last decade, educators and researchers have explored in some detail the characteristics of effective schools and schooling practices.[55] The research—which focuses on the individual school (as opposed to the individual teacher)—identifies clear patterns distinguishing schools that work and those that don't. These patterns—including effective leadership, shared goals, and sufficient time on task—support the findings of researchers both on effective use of technology and effective school reform. One critical and consistent finding: the beliefs, skills, and commitment of instructional leaders are the most important factors in determining how much and how well students learn.

Rules, policies, or laws that exist within individual states may—at least at first reading—seem to constrain educators from addressing some of the issues and concerns raised in this publication. Notwithstanding, effective schools research points out that individual schools can successfully give meaning to their learning goals, empower teachers, share information and resources, and in other ways reach out to today's new learners in effective ways. It suggests that fundamental institutional change may be accomplished most efficiently on a school-by-school basis.

Differentiated staffing and career ladders

Throughout the nation, many reform efforts have focused on the structure of the teaching profession, suggesting a variety of changes including four- and five-step career ladders and/or differentiated staffing patterns and pay scales. The reforms have both political and financial momentum and, at least in concept, may be more compatible with the demands of high-tech schooling than are traditional staffing patterns. Certainly the need to employ a variety of instructional media and more flexible teaching skills for contemporary learners suggests the need for a more versatile faculty with different kinds

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If we end up with less power for the teacher in the classroom, we will have failed when the dust from all the reports has settled down.

—Ernest Boyer

and levels of skill. Such structural reforms as career ladders offer the opportunity for teachers to move into new roles and responsibilities and offer reformers a useful mechanism to introduce programs of positive change. Furthermore, many such reforms define a greater role for teachers in the educational decision-making process through peer evaluation, curriculum development, and other leadership activities.

Despite its potential for moving toward effective information-age schooling, differentiated staffing is no panacea. Indeed, career ladders that simply rename existing teaching roles and responsibilities merely compound the problems and frustrations that created the momentum for reform in the first place. In short, a print-oriented, disempowered teacher by *any* name will find teaching information-age children a frustrating, difficult task.

Individualized instruction

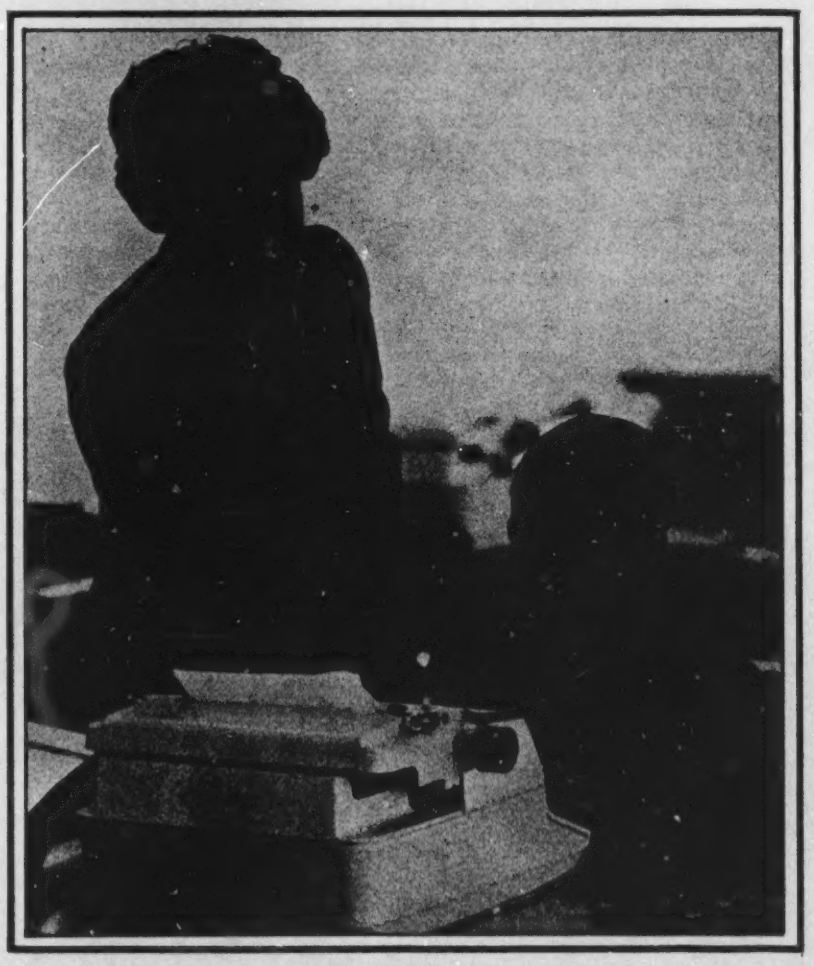
For most students, education is delivered via a traditional, standardized system, geared to age and average minimum expectations of groups of youngsters. The exception is special education, which offers a viable model of learning systems designed for individual students, employing a variety of instructional media and techniques, varied staffing patterns, and flexible evaluations. For these reasons, it is no coincidence that some of the most notable achievements in computer-assisted instruction have been with this population. As schools attempt to maximize the potential of the new technology and to shift staffing and curriculum systems to accommodate its capacities, the special education model may serve as a guide to constructive reform. One study[56] reports that students receive only six days of individual instruction in their twelve years of elementary and secondary education. Technology provides the only alternative at this time to overcoming this kind of homogenized delivery of services.

Team teaching

Once considered one of the most exciting innovations in our schools, team teaching is now less frequently used. Most schools rely on the one-teacher-to-a-classroom model. Indeed, studies show that many of the teaching teams now operating function more like the single-teacher model than as a team.[57] The changing nature of students, schools, society, and technology suggests that team teaching may be an idea deserving of fresh consideration.

Indeed, the technology itself may offer the most compelling argument for teamwork. As it becomes increasingly difficult for each teacher to master the range, volume, and depth of information and skills required to assume a new educative role, teachers will need to rely more and more on each other and on cooperative approaches to problem solving. "The successful application of computers to education," concludes one report, "will require expertise in subject matter, in teaching, in computer technology, in cognitive science, and in design. It is therefore necessary to provide means for bringing individuals with these capabilities together into team efforts."[58]

Further, true team approaches (not merely several teachers working with larger groups of students) require a greater decision-making role for the teachers and foster flexibility in curriculum design and student evaluation—characteristics that certainly are compatible with the effective use of instructional technology.



Multimedia instruction

A vast array of instructional tools is available to educators, and there is no answer to the question: Which is the better instructional medium? The question itself is wrong. Instead, educators must first ask what the realistic and appropriate educational objectives should be for computer-age children. What mental, social, vocational, and personal skills will they need? From those answers will flow informed choices about appropriate instructional tools.

Through print, students' minds are disciplined, focused, and aided in acquiring logical, systematic, and sequential thinking skills. Print fosters reflection, analysis, and imagination. Through the visual images of television and film, however, students are able to absorb information more efficiently, and they generally retain it longer. These visual media help to develop complex parallel processing skills, instill a much broader range of knowledge, and provide general familiarity with an abundance of information. With the interactive technologies, especially computers, students have the opportunity to engage in a personal way in the learning process through a medium that combines both the logical, disciplined demands of print and the visual immediacy and power of film.

Not only should media use flow from educational goals, but from an understanding of the individual child's needs, capabilities, and learning problems. At the Computers in Schools Project in New York City, officials reported that what students were able to do with computers was determined by a number of factors: "the computer language they had available; the manner in which they were grouped; how the teachers and administrators viewed the use of computers in the curriculum; how well the teacher understood the language and its potential; how well the teacher understood the learning process; and how student time was structured in terms of access to computers."[89] The computers proved most effective as an integral learning tool to the full curriculum, not simply as an add-on computer literacy program.

There is an important lesson to be learned—a model to look at—from the studies of educational media. Although each has its own strengths and limitations, ***all*** work better when used in conjunction with one or more other media. Tests consistently show that learning from television is enhanced if it is accompanied by discussion and reading. Reading comprehension, similarly, is increased if supported with film or discussion. Thus, computer-assisted instruction is likely to be most effective as a supplement to other instructional methodology.

Fears of a Computer Age

For many educators, the greatest concerns about computer technology have less to do with software or overpriced equipment than with the psychological and social effects of the new tools. Many of the characteristics of contemporary children are (at least potentially) magnified by computers. Educators, physicians, and parents report a range of problems attributable (directly or indirectly) to frequent or excessive computer use. These range from eyestrain and irritability to antisocial behavior.

Many of these concerns, however, presume a total shift from a predominantly print-oriented system to a predominantly computer-oriented system. If that were to happen—and it would be unfortunate—the concerns about isolation, eyestrain, and excessively logical, machine-like students would be very real. While those fears are not to be dismissed, it is important to keep in mind that instructional computers are not likely to become the sole educational medium or teacher's strategy. Other instructional media, such as books, films, or television—and particularly the teacher—will provide the balance.

Conclusions, arguments, observations

It is not that we cannot live without computers, but that we will be different people because we live with them.

—J. David Bolter,
Turing's Man:
Western Culture in the Computer Age

How shall we change?

As with all people and all things, public schooling is always caught up in the process of change. Communications technologies already alter the way we think and share our thinking, the way we relate to one another, and our intellectual and social needs. Further, there is public and professional unrest about schooling, dealing fundamentally with the questions of purpose, relevance, and excellence. As the needs of society take new shape in a period of transition, these kinds of issues inevitably—and appropriately—emerge for public debate.

Of paramount concern is the answer to a simple question: What will be the scope and substance of education reform in the schools, districts, and states of our nation?

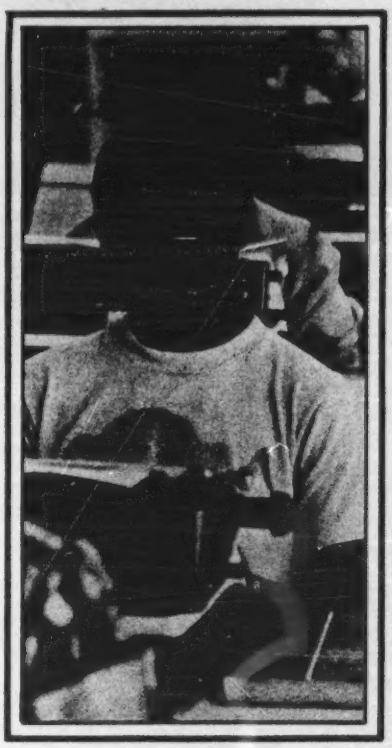
We have suggested that there is a case to be made for redesigning schooling from the bottom up so that it is responsive to the needs and realities of a high-tech age. That is an approach that conflicts sharply with the recommendations for change that are capturing a good deal of public attention and support.

One such remedy for America's schooling problems is presented in *A Nation at Risk: The Imperative for Educational Reform*, the report of the National Commisson on Excellence in Education. The report offers recommendations that would "generate reform . . . in fundamental ways and . . . renew the nation's commitment to schools and colleges of high quality throughout the length and breadth of our land."[60] We urge that these recommendations for reform be considered in the context of the critical issues that this paper addresses: the characteristics and needs of contemporary students; the limitations, strengths, and challenges that define the profession of teaching; and the range and usefulness of instructional tools that are available to teachers.

It is fair to say that the reforms suggested by the *Nation At Risk* report are of the "more-is-better," "back-to-basics" variety. The recommendations, similar to those of many other national reports, call for a longer school day and school year and for "far more homework." Further, they define "Five New Basics"[61] that should be required of secondary-level students: four years of English; three years each of math, science, and social studies; and a half-year of computer science. More demanding entrance requirements for teacher-preparation programs are recommended in the study, along with an eleven-month work year for teachers and salary increases tied to an evaluation plan.

These recommendations are not new—either in content or outlook. Not only do they echo reform proposals dating back to the 19th century, but they reflect a philosophy of schooling unchanged by the realities of 20th century life. In short, these proposed reforms presume that learning styles and needs of children are unchanging and, therefore, that the existing structures and patterns of schooling are sound and—if increased in effectiveness and/or intensity—will successfully prepare youngsters for the future.

This paper suggests very different kinds of reform. It agrees with the observer who wrote that the *Nation at Risk* proposals fail to provide "any sign of what they claim to deliver: that is, *fundamental* reform. Even if everything proposed in [the] report, and in most of the other reports as well, were put into effect, the resulting school would be fundamentally no different from the school of today. . . . Teachers would still be standing or sitting in front of some twenty to thirty-five mostly passive students of the same age and giving out the same information at the same time to all these students, regardless of their individual abilities, cultural backgrounds, or learning styles."[62] It's an approach to schooling that has survived over the years, "because it is the easiest to administer."[63] It is also an approach that accurately mirrors the biases of print: standardized, linear, systematic, inflexible, and verbal—and at odds with the learning needs of contemporary children.



At least since the 1930s, "educators have advocated learning experiences beyond the school walls. Today's speed of change and the serious nature of global problems, which lead to turbulence and to wide-scale disorder, make such extended learning more important than ever. Traditional education with its red tape and regulations, its passivity and 'right' answers, is the old way of doing things. The demands of the present and of the future clearly call for new ways of doing things. Active, dynamic experiences, sponsored by the schools but going beyond its confines, help to satisfy this need."[64]

So, while a belief in the need for change in schooling is increasingly widespread, the debate on the nature and dimensions of change has perhaps only begun. But that may not be so. It is also possible that reforms will be enacted hastily, without sufficient debate and reflection. It is our argument that the fundamental nature of the new technologies and the directions in which they are moving society are in direct conflict with the fundamental nature and structures of the existing teaching system. It is that conflict that is at the heart of tensions and turmoil in the classroom: between teachers who "can't reach" students and pupils who are bored; between "verbal" instructional tools and "visual" students; between sequential learning goals and increasingly complex social demands on students' minds.

Furthermore, there are trends at work that are likely to widen the gap between the new technological society and the established school system. First, teachers are not involved in a systematic way in most of the current reform efforts. Although this is particularly true (and ironic) with respect to the introduction of computer technologies, it holds as well for most (in many cases unsuccessful) reform efforts in recent decades.

Second, most of the current reform proposals pay little attention to the need to modify roles or the beliefs that support current practices. A case in point is the number of proposals to improve teaching by strengthening subject matter instruction in teacher

Environmental Collapse?

In his book, *Education in the Computer Age*, Stanley Pogrow talks about the need to respond to changing technological pressures and needs, or risk what he calls "environmental collapse." This term describes a process "wherein dissatisfied constituents do not try to change an organization. Instead, they abandon it for an alternative, economically compelling service or product made possible by a fundamentally new technology. Historical examples of . . . victims of environmental collapse include scribes, artisans, ocean liners, and the Pony Express. More recent examples are the loss of domestic [illegible]ominance by U.S. [illegible] and the failure of the [illegible] Service to obtain its [illegible]bjective to control electronic mail."

A Better Delivery System?

"Given the will and imagination, it will soon be possible to use computers as the *primary* educational information-delivery system for most of the basic cognitive material now presented in the classroom. This will free teachers to serve as tutors, as seminar leaders, and as lecturers for special occasions. Best of all, it will make individualized, high-interaction education available to all students at a bearable cost, whatever their ability." (emphasis added) While all the costs of education continue to rise, "computers are getting cheaper every year—cheaper and more powerful."

—George Leonard
"The Great School Reform Hoax"

preparation programs. Proponents of these reforms criticize current training programs for their emphasis on "pedagogy" and demand increased rigor in information courses.[65] These reforms call for teacher training institutions to produce teachers who are *better at communicating information*. Ironically, the nature of the technology and the changing demands of society suggest that to be effective, teachers need *not* be better information media, but something quite different: educators, that is, experts in the learning process.

Third, many teacher training institutions have not embraced, and do not incorporate in their programs, technology-related reform efforts or pedagogical research on effective practice. Inevitably, however, these factors will be required to play a key role in any long-term institutional change. Obviously these are generalizations; much exciting educational research is being conducted in leading teacher training institutions. These exceptions aside, however, most teacher training institutions have virtually no contact with the growing body of research on how learning takes place and on incentives and barriers to learning. Understanding of instructional media—other than print—is very low. Although most teachers have some exposure to at least one "educational media" course, it is generally cursory and incompletely tied to the other pedagogical instruction they receive. In short, there is no sense that the use of various communications media (such as film, television, or computers) is regarded as a basic teaching skill or that it is taught as such.

Finally, the perception of the teacher as a medium for transmitting information is widely held—in and outside of the education community—and widely held beliefs are formidable barriers to change. The emerging dilemma is this: most of the training programs, staffing patterns, and curriculum decisions are based on a perception of the teacher as information source. At the same time, there is startling growth in the availability of alternative information sources. Not only will it be difficult to alter firmly entrenched patterns without altering underlying beliefs, but because other sources of information are plentiful, there is also a danger of failing to develop new and meaningful roles for teachers.

A Model in the Private Sector: The Waterford School

Located in Orem, Utah, the Waterford School is a private, tuition-free K-12 experimental school that functions under the auspices of the World Institute for Computer-Assisted Teaching. While offering a rich academic menu to students, the school exists to allow the institute to conduct research on the development and implementation of hardware and educational materials for schools.

With a staff of over 30 Ph.Ds drawn from around the world, WICAT and the Waterford School are engaging in a research agenda on the cutting edge in the exploration of the learning potential of electronic technology. Included is basic research in such areas as:

- How to use computers wisely and well in formal educational settings and how to share this information effectively with public schools in order to help strengthen their CAI programs.
- The development of new techniques for teaching courses in a variety of academic disciplines such as writing and algebra.
- Ways of using the new technologies for minority populations who have special training needs.
- The development of learner profiles for each student. "Without question," says WICAT Chairman Dustin Heuston, "the great new frontier in the use of computers will be in the construction of learner profile programs that will help teachers, schools, parents, and students understand their personal learning profiles. That is, they will learn more about their latent talents, their individual style in learning, and any serious deficiencies that they might have, such as dyslexia. The learner profile programs will stand in place of large batteries of tests administered by sophisticated psychologists. They will offer to the poorest child a broad range of diagnostic information which will then automatically link him into remedial programs and standard curricula at the appropriate points. At the same time, the programs will alert the supervising adults to the status of the learner."
- Computer adaptive testing. The institute is probing the frontiers of sophisticated testing that will allow rapid branching and probing of a student's actual knowledge far more accurately than the standard paper-and-pencil test. The testing will not only be much more sophisticated and accurate, but it also will take much less time.
- Cognitive errors. "Most students," explains Heuston, "suffer from standard cognitive errors which leave them attempting to solve problems with flawed algorithms. These flawed algorithms have 'bugs' that keep the student from thinking clearly in that area, or in getting the problem correct. The common bugs, or blocking metaphors, will have to be identified so as to allow learning to proceed more rapidly." The institute's early research in cognitive errors has shown that there are some very common bugs that can be clarified quickly with the help of computer diagnosis.
- The application of artificial intelligence techniques to learning. There appear to be helpful lessons that have been learned in using artificial intelligence techniques to speed up and solidify learning. WICAT is implementing LISP, an artificial intelligence language, to help accelerate its efforts in applying the new techniques to such staples as the teaching of algebra or the development of new languages such as LOGO.

The institute will continue to do basic research in validating the impact of computer instruction on the students of its own school, and wherever the materials are tested in external sites. Such test sites have been established in many locations throughout the country.

The agenda

Careful examination of the current proposals for educational change presents the education community with a number of critical tasks:

1. In the short term, the formidable challenge is to prepare teachers to use the new technologies with skill and understanding. The evidence is clear that, if the equipment now being purchased by school systems across the country is to make a valuable contribution to the education of children, it must be put in the hands of educators who know how and when to use it, recognize its strengths and limitations, and endorse its use. This stipulation applies to the use of television, computers, video recorders, films, or calculators.

Given the reality that 80 percent of those now teaching will still be teaching ten years from now, the task is largely one of retraining existing staff. However, the retraining process requires more than an inservice course on computer operation. Multimedia instruction requires different skills from print-dominated instruction. More, it requires different perspectives and thinking. Just as each medium affects the way we think, perceive, and learn, so too must each medium be understood and used differently. We have been arguing in these pages that the products and processes of technology are critical factors in shaping the future. If that is true, then certainly our children's teachers must be thoroughly familiar with the instructional strengths and limitations embedded on these tiny microchips and understand and *use* the images that are forever on our screens.

2. This emphasis on the immediate need for retraining existing staff does not for a moment deemphasize the crucial role of teacher training institutions in preparing tomorrow's teachers. There is a clear need for prospective teachers to acquire multimedia skills, to learn how to use technology for individual and group instruction, and to understand how to help students deal effectively with information overload, or, in contemporary coinage, "info-glut." Providing these student teachers with "computer literacy," while certainly of value, is far too narrow a focus. To work well with contemporary learners, successful teachers will need media literacy and image literacy, human relations skills and training, and a new understanding of ways to motivate students to learn.

3. We actually know very little about the learning styles, needs, and mental processes of media-age children. The speculations, suppositions, and assumptions that underlie much that has been written—including this publication—need to be better understood and verified. Research of the kind going on at the Waterford School (see box) deserves broad and sustained support.

4. In the context of these many different ideas and projections, it is time to review and reshape public school curricula to address the changing needs of students and to use the new technology effectively. We need to examine curricula and programs to see if they address interpersonal skills, *media* literacy, and multiple/complementary use of instructional approaches.

5. Another challenge confronting educators is a broader one—one that will be addressed gradually through the democratic processes that continually shape and reshape our public schools. Schools generally, and the teaching profession specifically, will need to reconstruct the roles, skills, and responsibilities of teachers in order to address the critical need for the enriching and leavening quality of human interaction in a high-tech age. The new technologies—and high-tech society—foster certain kinds of behavior and neglect or diminish others. If the computer's tendencies to stress logic, dissociation, and impatience are to be balanced with capacities for intuition, mental discipline, and cooperation, it will be because of human intervention. There are few institutions as well placed in society today to provide that balance as are our public schools. And there are few professionals in our culture better suited to fill that role than our public school teachers.

A more specific, complex, and complete agenda will evolve in community gatherings, assembly halls, and countless board meetings in towns, counties, and states throughout the country as the schools attempt to formulate a response to the revolutionary implications of the information technologies. Considering the pace of change fueled by these technologies, it is perhaps accurate to say that the time available for putting such a response in place is very brief indeed. The task has already begun. The purchase of each computer is an expression of public education's interest in engaging in the process of change. As one writer, commenting on learning and technology, puts it: "What is happening now is an empirical question. What can happen is a technical question. But what will happen is a political question, depending on social choices."[66]

We understand that "educational reform is not a substitute for societal reform. While education may fail to implement innovations successfully, it may be equally true that social, political, and economic forces inhibit change within the educational system."[67] In other words, everyone is implicated as we move to respond more positively and effectively to the changing learning needs of our children. While we can encourage change, embrace it, and reach out for it, it is good for us to remember that none of us learns new ideas all at once. "Change will not come faster than the corresponding human skills development. Evolution is the characteristic label, not revolution."[68] For all of us, change is a process, not an event. It begins, we believe, with a change of mind.

Notes

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13. Postman, p. 76.
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Acknowledgements: *Photographs courtesy of the Orange County Board of Education, Orange County, NC, and the Superintendent of Schools, Dr. Dan G. Lunsford and his staff. Photographs by Joshua Hartford.*